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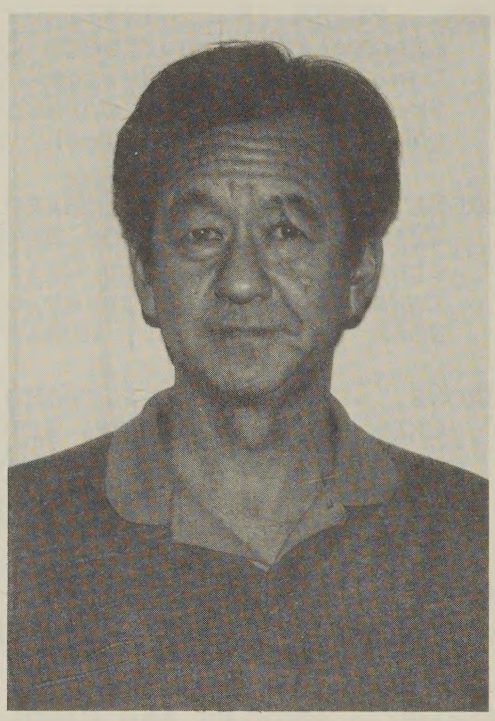
SWFC Scientists Recognized for Outstanding Publications for 8th year

For the past 8 years, the NMFS Outstanding Publications Awards for Fishery Bulletin have been bestowed on scientists of the Southwest Fisheries Center. In 1986, Gail Theilacker of the Coastal Fisheries Resources Division received the award for best publication in Fishery Bulletin and Susumu Kato of the Tiburon Laboratory received the award for best publication in Marine Fisheries Review.

GAIL THEILACKER



SUSUMU KATO

Fishery Biologist Gail Theilacker was awarded the 1986 NMFS Outstanding Publication for volume 84 of Fishery Bulletin for her publication "Starvation-induced mortality of young sea-caught jack mackerel, *Trachurus symmetricus*, determined with histological and morphological methods" (volume 84, number 1, pages 1-17). For volume 47 of Marine Fisheries Review, the NMFS Outstanding Publication Award went to Fishery Biologist Susumu Kato and his co-author Stephen C. Schroeter for their publication on "Biology of the red sea urchin, *Strongylocentrotus franciscanus*" , and its fishery in California" (volume 47, number 3, pages 1-20).

The publications were judged by Willis Hobart, editor of the Marine Fisheries Review, and four past editors of the Fishery Bulletin: Bruce Collette, Reuben Lasker, William Richards, and Carl Sindermann. Among the criteria used in judging the publications were breadth and depth of coverage and knowledge of a field, excellence of experimental design or methodology, importance of scientific contribution, and originality of thought, analyses, and syntheses.

The list of 1987 publications below is testimony to the diligence and productiveness of Center scientists. In 1987, Center scientists published 84 papers, 6 peer reviewed papers and 23 Technical Memorandums.

PUBLICATIONS - 1987

ADAMS, PETER B. 1987. The diet of widow rockfish *Sebastes entomelas* in northern California. *In* William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish, p. 37-41. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

AMBROSE, DAVID A., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND CELESTE R. SANTOS METHOT. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1955. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-83, 185 p.

AMBROSE, DAVID A., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND CELESTE R. SANTOS METHOT. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1960. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-88, 253 p.

ALVARIÑO, ANGELES. 1987. *Spadella pimukatharos*, a new benthic Chaetognath from Santa Catalina Island, California. Proc. Biol. Soc. Wash. 100(1):125-133.

ALVARIÑO, ANGELES AND CAROL A. KIMBRELL. 1987. Abundance of zooplankton species in California coastal waters during April 1981, February 1982, March 1984 and March 1985. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-74, 59 p.

BALAZS, GEORGE H. (Compiler). 1987. Annotated list of shark attacks in the Hawaiian Islands--July 1987. Hawaii Fish. News 12(8):12-13.

BALAZS, GEORGE H., ROBERT G. FORSYTH, AND ALAN K. H. KAM. 1987. Preliminary assessment of habitat utilization by Hawaiian green turtles in their resident foraging pastures. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-71, 107 p.

BARSS, WILLIAM H. AND TINA WYLLIE ECHEVERRIA. 1987. Maturity of widow rockfish *Sebastes entomelas* from the northeastern Pacific, 1977-82. *In* William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish, p. 13-18. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

BOEHLERT, G. W. 1987. Meeting Reports: First Pacific Symposium on Marine Sciences. EOS Trans. Am. Geophys. Union 68:199.

BOEHLERT, G. W. AND A. GENIN. 1987. A review of the effects of seamounts on biological processes. *In* B. H. Keating, P. Fryer, R. Batiza, and G. W. Boehlert (eds.), Seamounts, islands, and atolls, p. 319-334. Geophys. Monogr. 43. [Am. Geophys. Union.]

BOEHLERT, G. W. AND B. C. MUNDY. 1987. Recruitment dynamics of metamorphosing English sole, *Parophrys vetulus*, to Yaquina Bay, Oregon. Estuarine Coastal Shelf Sci. 25:261-282.

BOEHLERT, G. W., M. KUSAKARI, AND J. YAMADA. 1987. Reproductive mode and energy costs of reproduction in the genus *Sebastes*. *In* Proceedings of the International Rockfish Symposium, Anchorage, Alaska USA, October 20-22, 1986, p. 143-152. Univ. Alaska, Alaska Sea Grant Rep. 87-2.

BOEHLERT, G. W. AND M. M. YOKLAVICH. 1987. Long-term cycles of growth in *Sebastes*: Extracting information from otoliths. *In* Proceedings of the International Rockfish Symposium, Anchorage, Alaska USA, October 20-22, 1986, p. 197-207. Univ. Alaska, Alaska Sea Grant Rep. 87-2.

BOGGS, C. H. AND S. G. POOLEY. 1987. Forces of change in Hawaii's aku (skipjack tuna) industry, 1986 - workshop summary. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-72, 70 p.

BOURKE, R. E., J. BROCK, AND R. M. NAKAMURA. 1987. A study of delayed capture mortality syndrome in skipjack tuna, *Katsuwonus pelamis* (L). J. Fish Dis. 10:275-287.

BRILL, R. W. 1987. On the standard metabolic rates of tropical tunas, including the effect of body size and acute temperature change. Fish. Bull., U.S. 85:25-35.

COOPERRIDER, CANDIS L. 1987. Commercial passenger fishing vessel landings of widow rockfish *Sebastes entomelas* in central California. *In* William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish, p. 49-52. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

DYKE, BRUCE, JACK HEGENAUER, PAUL SALTMAN AND R. MICHAEL LAURS. 1987. Isolation and characterization of a new zinc-binding protein from albacore tuna plasma. Biochemistry 26:3228-3234.

ECHEVERRIA, TINA WYLLIE. 1987. Relationship of otolith length to total length in rockfishes from northern and central California. Fish. Bull., U.S. 85(2):383-387.

ECHEVERRIA, TINA WYLLIE. 1987. Thirty-four species of California rockfishes: Maturity and seasonality of reproduction. Fish. Bull., U.S. 85(2):229-250.

FIEDLER, PAUL C. AND HANNAH J. BERNARD. 1987. Tuna aggregation and feeding near fronts observed in satellite imagery. Continental Shelf Res. 7:871-881.

GERRODETTE, T. In Press. Dynamic response analysis. II. Evaluation of dynamic response analysis in a simulated no-harvest case. Mar. Mammal Sci.

GERRODETTE, T. 1987. A power analysis for detecting trends. Ecology 68:1364-1372.

GILPATRICK, J. W., W. F. PERRIN, S. LEATHERWOOD, AND L. SHIROMA. 1987. Summary of distribution records of the spinner dolphin, *Stenella longirostris*, and the pantropical spotted dolphin, *S. attenuata*, from the western Pacific Ocean, Indian Ocean and Red Sea. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-89, 42 p.

HARRISON, CRAIG S. AND M. P. SEKI. 1987. Trophic relationships among tropical seabirds at the Hawaiian Islands. *In* J. P. Croxall (ed.), Seabirds: feeding ecology and role in marine ecosystems, Chapter 13, p. 305-326. Cambridge University Press, England.

HARRISON, JOHN T. 1987. The 40 MW_e OTEC plant at Kahe Point, Oahu, Hawaii: A case study of potential biological impacts. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-68, 105 p.

HIGHTOWER, J. E. AND G. D. GROSSMAN. 1987. Optimal policies for rehabilitation of overexploited fish stocks using a deterministic model. Can. J. Fish. Aquat. Sci. 44(4):803-810.

HOCHACHKA, P. W. AND R. W. BRILL. In press. Autocatalytic pathways to cell death: A new analysis of the tuna burn problem. Fish. Physiol. Biochem.

HOCHACHKA, P. W. AND R. W. BRILL. 1987. Autocatalytic pathways to cell death: A new analysis of the tuna burn problem. Fish Physiol. Biochem. 4(2):81-87.

HOLT, R. S. 1987. Estimating density of dolphin schools in the eastern tropical Pacific Ocean by line transect methods. Fish. Bull., U.S. 85(3):419-434.

HOLT, RENNIE S. AND ALAN JACKSON. 1987. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel *McArthur*, July 29-December 6, 1986. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-77, 10 p.

HOLT, RENNIE S. AND JOHN COLOGNE. 1987. Factors affecting line transect estimates of dolphin school density. J. Wildl. Manage. 51(4):836-843.

HOLT, RENNIE S. AND STEPHANIE N. SEXTON. 1987. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel *David Starr Jordan*, July 29-December 5, 1986. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-76, 11 p.

HOLT, R. S., T. GERRODETTE, AND J. B. COLOGNE. 1987. Research vessel survey design for monitoring dolphin abundance in the eastern tropical Pacific. Fish. Bull., U.S. 85(3):435-446.

HUDGINS, L. L. AND S. G. POOLEY. 1987. Growth and contraction of domestic fisheries: Hawaii's tuna industry in the 1980s. *In* D. J. Doulman (ed.), Tuna issues and perspectives in the Pacific islands region, p. 225-241. East-West Center, Honolulu, 314 p.

HUPPERT, DANIEL D. (Editor). 1987. Limited access alternatives for the Pacific groundfish fishery. NOAA Tech. Rep. NMFS-52, 45 p.

HUPPERT, DANIEL D. 1987. Introduction: Limited access, what is it and why? *In* Daniel D. Huppert (ed.), Limited access alternatives for the Pacific groundfish fishery, p. 1-5. NOAA Tech. Rep. NMFS-52.

HUPPERT, DANIEL D. AND CHARLES S. KORSON. 1987. Profile of the groundfish fishery. *In* Daniel D. Huppert (ed.), Limited access alternatives for the Pacific groundfish fishery, p. 7-11. NOAA Tech. Rep. NMFS-52.

HUPPERT, DANIEL AND DALE SQUIRES. 1987. Potential economic benefits and optimum fleet size in the Pacific coast trawl fleet. Mar. Res. Econ. 3(4):297-318.

HUPPERT, DANIEL D. AND DALE SQUIRES. 1987. Potential economic benefits of limited entry. *In* Daniel D. Huppert (ed.), Limited access alternatives for the Pacific groundfish fishery, p. 23-26. NOAA Tech. Rep. NMFS-52.

HUPPERT, DANIEL D. AND R. BRUCE RETTIG. 1987. Elements of a limited access program. *In* Daniel D. Huppert (ed.), Limited

access alternatives for the Pacific groundfish fishery, p. 13-17. NOAA Tech. Rep. NMFS-52.

JAHN, ANDREW E. AND PAUL E. SMITH. 1987. Effects of sample size and contagion on estimating fish egg abundance. Calif. Coop. Oceanic Fish. Invest. Rep. 28:171-177.

JOHANOS, THEA C., ALAN K. H. KAM, AND ROBERT G. FORSYTH. 1987. The Hawaiian monk seal on Laysan Island: 1984. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-70, 38 p.

KEATING, B. H., P. FRYER, R. BATIZA, AND G. W. BOEHLERT. (EDS.). 1987. Seamounts, islands, and atolls. Geophys. Monogr. 43, 405 p. [Am. Geophys. Union.]

KENDALL, ARTHUR W., JR. AND WILLIAM H. LENARZ. 1987. Status of early life history studies of northeast Pacific rockfishes. *In* Proceedings of the International Rockfish Symposium, October 1986, Anchorage, Alaska, p. 99-128. Univ. Alaska, Alaska Sea Grant Rep. 87-2.

KENDALL, A. W., JR., M. E. CLARKE, M. M. YOKLAVICH, AND G. W. BOEHLERT. 1987. Distribution, feeding, growth of larval walleye pollock, *Theragra chalcogramma*, from Shelikof Strait, Gulf of Alaska. Fish. Bull., U.S. 85:499-521.

KLEIBER, P., A. W. ARGUE, AND R. E. KEARNEY. 1987. Assessment of Pacific skipjack tuna (*Katsuwonus pelamis*) resources by estimating standing stock and components of population turnover from tagging data. Can. J. Fish. Aquat. Sci. 44(6):1122-1134.

KLEIBER, P. AND B. BAKER. 1987. Assessment of interaction between North Pacific albacore, *Thunnus alalunga*, fisheries by use of a simulation model. Fish. Bull., U.S. 85, in press.

LENARZ, WILLIAM H. 1987. A history of California rockfish fisheries. *In* Proceedings of the International Rockfish Symposium, October 1986, Anchorage, Alaska, p. 35-41. Univ. Alaska, Alaska Sea Grant Rep. 87-2.

LENARZ, WILLIAM H. 1987. Ageing and growth of widow rockfish. *In* William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish. Proceedings of a workshop, Tiburon, California, December 11-12, 1980, p. 31-35. NOAA Tech. Rep. NMFS-48.

LENARZ, WILLIAM H. AND DONALD R. GUNDERSON (Editors). 1987. Widow rockfish. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48, 57 p.

MAJORS, ANTHONY P. 1987. United States North Pacific albacore fishery, 1961-1980, Vol. 1. U.S. Dep. Commer., NOAA, Tech. Memo., NOAA-TM-NMFS-SWFC-73, 11 p.

MOFFITT, ROBERT B. AND JEFFREY J. POLOVINA. 1987. Distribution and yield of the deepwater shrimp *Heterocarpus* resource in the Marianas. Fish. Bull., U.S. 85:339-349.

MOKSNESS, ERLEND, JOHN BUTLER, AND RICHARD L. RADTKE. 1987. Estimation of age and growth rate in Norwegian spring spawning herring (*Clupea harengus* L.) larvae and juveniles. Sarsia 72:341-342. Bergen. ISSN 0036-4827.

MOSER, H. G. AND J. L. BUTLER. 1987. Descriptions of reared larvae of 6 species of *Sebastes*. *In* W. H. Lenarz and D. R. Gunderson (eds.), Widow rockfish. Proceedings of a Workshop, Tiburon, California, December 11-12, 1980, p. 19-29. NOAA Tech. Rep. NMFS-48.

MOSER, H. G., P. E. SMITH, AND L. E. EBER. 1987. Larval fish assemblages in the California Current region, 1954-1960, a period of dynamic environmental change. Calif. Coop. Oceanic Fish. Invest. Rep. 28:97-127.

MUNDY, B. C. 1987. NMFS, Southwest Fisheries Center, Honolulu Laboratory, Honolulu, Hawaii: Insular Resources Investigation. Early Life History Section, Am. Fish. Soc. Newsl. 8(1):12-13.

MURANO, MASAAKI AND JAMES R. CHESS. 1987. Four new mysids from California coastal waters. J. Crust. Biol. 7(1):182-197.

OWEN, R. W. AND CAROL A. KIMBRELL. 1987. Micropatch sampler data. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-91, 54 p.

PERRIN, W. F., E. D. MITCHELL, J. G. MEAD, D. K CALDWELL, M. C. CALDWELL, P. J. H. van BREE, AND W. H. DAWBIN. 1987. Revision of the spotted dolphins, *Stenella* spp. Mar. Mammal Sci. 3(2):99-170.

PITMAN, ROBERT L., ANELIO AGUAYO L., AND JORGE URBÏN R. 1987. Observations of an unidentified beaked whale (*Mesoplodon* sp.) in the eastern tropical Pacific. Mar. Mammal Sci. 3(4):345-352.

POLOVINA, J. J. 1987. Assessment and management of deepwater bottom fishes in Hawaii and the Marianas. *In* J. J. Polovina and S. Ralston (eds.), Tropical snappers and groupers: Biology and fisheries management, p. 505-532. Westview Press, Boulder and London.

POLOVINA, J. J. AND S. RALSTON (Editors). 1987. Tropical snappers and groupers: Biology and fisheries management. Westview Press, Boulder and London, 659 p.

POMMERANZ, TILMAN AND H. GEOFFREY MOSER. 1987. Data report on the vertical distribution of the eggs and larvae of northern

anchovy, *Engraulis mordax*, at two stations in the Southern California Bight. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-75, 9 p.

POOLEY, S. G. 1987. Demand considerations in fisheries management--Hawaii's market for bottom fish. *In* J. J. Polovina and S. Ralston (eds.), Tropical snappers and groupers: Biology and fisheries management, p. 605-638. Westview Press, Boulder and London.

RALSTON, S. 1987. Mortality rates of snappers and groupers. *In* J. J. Polovina and S. Ralston (eds.), Tropical snappers and groupers: Biology and fisheries management, p. 375-404. Westview Press, Boulder and London.

REILLY, S. B. 1987. Reanalysis of rate of change in the California-chukotka gray whale stock, 1967/68-1979/80. Rep. Int. Whal. Commn 37:347-349.

SAKAGAWA, GARY T. 1987. Effects of tropical tuna fisheries on non-target species. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-69, 29 p.

SANDKNOP, ELAINE M., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND CELESTE R. SANTOS METHOT. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1952. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-80, 207 p.

SANDKNOP, ELAINE M., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND CELESTE R. SANTOS METHOT. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1958. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-86, 248 p.

SQUIRES, D. 1987. Fishing effort: Its testing, specification, and internal structure in fisheries economics and management. J. Environ. Econ. Manage. 14(3):268-282.

SQUIRES, D. 1987. Long-run profit functions for multiproduct firms. Amer. J. Agr. Econ. 69(3):558-569.

SQUIRES, D. 1987. Public regulation and the structure of production in multiproduct industries: An application to the New England otter trawl fleet. Rand J. Econ. 18(2):232-247.

STEVENS, ELIZABETH G., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND MORGAN S. BUSBY. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1953. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-81, 186 p.

STEVENS, ELIZABETH G., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND MORGAN S. BUSBY. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1956. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-84, 189 p.

STEVENS, ELIZABETH G., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND MORGAN S. BUSBY. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1959. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-87, 273 p.

SUMIDA, BARBARA Y., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND DEBORAH L. SNOW. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1954. U.S. Dep. Commer., NOAA Tech Memo., NOAA-TM-NMFS-SWFC-82, 207 p.

SUMIDA, BARBARA Y., RICHARD L. CHARTER, H. GEOFFREY MOSER, AND DEBORAH L. SNOW. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1957. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-85, 225 p.

THEILACKER, GAIL H. 1987. Feeding ecology and growth energetics of larval northern anchovy, *Engraulis mordax*. Fish. Bull., U.S. 85(2):213-228.

THOMSON, CYNTHIA J. AND DANIEL D. HUPPERT. 1987. Results of the Bay area sportfish economic study (BASES). U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-78, 29 p.

UEBER, EDWARD. 1987. Widow rockfish fishery. *In* William H. Lenarz and Donald R. Gunderson (eds.), Widow rockfish, p. 53-56. Proceedings of a workshop, Tiburon, California, December 11-12, 1980. NOAA Tech. Rep. NMFS-48.

WAHLEN, BRUCE E., RUTH B. MILLER, AND CAROLYN J. MACKY. 1987. Composition of the incidental kill of small cetaceans in the US purse-seine fishery for tuna in the eastern tropical Pacific during 1985. Rep. Int. Whal. Commn 37:353-355.

WETHERALL, J. 1987. Honolulu Laboratory surveys fish resources in South Pacific. Hawaii Fish. News 12(4):29.

WETHERALL, J. A., J. J. POLOVINA, AND S. RALSTON. In Press. Estimating growth and mortality in steady state fish stocks from length-frequency data. *In* D. Pauly and G. R. Morgan (eds.), Length-based methods in fishery research. International Center for Living Aquatic Resource Management, ICLARM Conference Proceedings 13, Manila.

WHIPPLE, J. A., R. B. MacFARLANE, M. B. ELDRIDGE, AND P. BENVILLE, JR. 1987. The impacts of estuarine degradation and chronic pollution on populations of anadromous striped

bass (*Morone saxatilis*) in the San Francisco Bay-Delta, California: A summary. *In* D. M. Goodrich (ed.), San Francisco Bay: Issues, resources, status, and management, pp. 77-106. U.S. Dep. Commer., NOAA Estuary-of-the-Month Seminar Series No. 6, NOAA Estuarine Programs Office, Washington, D.C., 159 p.

WILSON, C. E., W. F. PERRIN, J. W. GILPATRICK, JR., AND S. LEATHERWOOD. 1987. Summary of locality records of the striped dolphin, *Stenella coeruleoalba*. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-90. 27 p.

WOLF, PATRICIA AND PAUL E. SMITH. 1987. The relative magnitude of the 1986 Pacific sardine spawning biomass off California. Calif. Coop. Oceanic Fish. Invest. Rep. 28:21-26.

WYLLIE ECHEVERRIA, T. 1987. Relationship of otolith length to total length in rockfishes from northern and central California. Fish. Bull., U.S. 85(2):383-387.

WYLLIE ECHEVERRIA, T. 1987. Thirty-four species of California rockfishes: maturity and seasonality of reproduction. Fish. Bull., U.S. 85(2):229-250.

YOKLAVICH, M. M. AND G. W. BOEHLERT. 1987. Daily growth increments in otoliths of juvenile black rockfish, *Sebastes melanops*: an evaluation of autoradiography as a new methood of validation. Fish. Bull., U.S. 85, in press.

COASTAL FISHERIES RESOURCES DIVISION
La Jolla, California

COASTAL EASTERN PACIFIC POPULATION BIOLOGY OF FISHES

Method to Analyze Fish Condition and Growth Using a Nucleic Acid Index Developed

Fishery Biologist Gail Theilacker, on detail from the Southwest Fisheries Center to the Northwest and Alaska Fisheries Center, recently developed an assay for growth-linked nucleic acids in pollock. The objective of this study was to produce a protocol for assessing RNA and DNA content of larval fish tissue at the cellular level in order to analyze the condition and growth of the fish. Because traditional nucleic acid techniques are not extremely sensitive, assays require single or multiple whole animal homogenates. In larval fish, cellular response to growth varies among tissues. Thus, using whole animal homogenates to assess RNA and DNA content complicates interpretation because homogenizing integrates these tissue-specific responses.

Theilacker used a Flow Cytometer to identify the nucleic acids in single cells. She designed a protocol for pollock tissue: 1) dissection and storage to ensure nucleic acid stability, 2) dispersion of single cell suspensions, and 3) storage and staining of the cells.

To determine the response of the RNA/DNA index to variations in growth, laboratory experiments will be designed that vary feeding regime and temperature. For additional calibration, Theilacker started pollock tissue cultures (brain, liver, muscle, spleen, kidney and heart) that will be grown on optimum and minimum culture media. Maximum and minimum RNA levels maintained on these media will be used to bracket the nucleic acid index. (G. Theilacker, FTS 893-7125)

Microscale Variations of Small Plankton in Coastal and Pelagic Environments Studied

Culminating a decade of research, Oceanographer Robert Owen has produced a manuscript on patchiness of small plankton organisms that occur in a variety of ocean environments. In contrast to traditional assumptions that the upper layer of the sea constitutes a well-mixed, homogeneous environment with uniform blends and concentrations of plankton species, Owen's work reveals a miniature seascape replete with the variety and pattern of an English country garden. Under all but full-storm mixing, partly overlapping aggregations of diatom, protozoan and small crustacean species fill a similarly patchy environment.

Although subsurface patchiness in the sea was never before investigated systematically, its existence was suspected from indirect evidence. For example, rations to support small foragers such as fish larvae appeared almost always to be too low--the forager expended more energy to get to the next food particle than was gained by eating it. But the classical method of determining rations involved sampling over inappropriately large volumes or distances; if rations were organized into small patches, the average concentration would be much lower than the concentration within a patch. If the forager took advantage of patches, it would find adequate rations where the unaware observer would predict death by starvation.

Working with samples drawn at intervals as small as a few centimeters from subsurface ocean layers, Owen and his co-workers found "microscale" variations of small plankton and of the environment that often exceeded errors of sampling and measurement. On a series of cruises from 1975 to 1982, a range of site conditions were sampled off California, Norway and Perú to determine the generality of the microscale patchiness phenomenon, its properties, and the mechanisms that produce and control it.

Plankton patches measuring less than a meter frequently were 5 to 20 times more populated than spaces between batches, and contained species mixes that were different from the species mixes in surrounding water or in other patches in the vicinity.

Environmental characteristics appeared to affect the degree of organism patchiness more than behavioral modes of the organisms. This suggested predominant physical control of small-scale plankton patchiness. In the aggregate, patchiness of organisms was greater during daylight than at night, at lower wind speeds, in more stable layers of the ocean, and over continental slopes. Patchiness was greater in small zones with large temperature gradients, and under oligotrophic conditions (lower concentrations of nutrients, particulates, and chlorophylls). Patchiness of organisms also was greater where nutrients and particulates were more patchy.

Microscale patchiness of small plankton is a recurrent feature of the environment of small foragers and may affect their growth and survival. Patchiness appears to be predictable over large domains from the mixing environment, e.g. wind and stability. Regional assessment of microscale patchiness can contribute to management of exploited stocks of marine organisms whose recruitment depends on food supply at early stages of their life-history. (R. Owen, FTS 893-7132)

Economist Analyzes Angler Choices for Model

Cynthia Thomson, Industry Economist, continues her analysis of the data collected for the Bay Area Sportfish Economic Study (BASES). For this study, questionnaires were sent to recreational saltwater fishermen residing in 19 central and northern California coastal countries. The survey period extended from July 1985 through August 1986.

Thomson is using these data to model angler choices regarding fishing site, fishing mode, target species and number of trips taken. An important part of this analysis is to show how changes in angler characteristics (such as income and angling skill), costs associated with fishing, and characteristics of the fishing experience (such as catch rates and weather) affect 1) the choices made by anglers, and 2) the economic value of the recreational fishing experience to the angler.

Thomson is currently working on the extensive data summaries necessary to do this type of analysis. These include: 1) construction of an origin-destination matrix, showing the travel distance between each of the 300-plus zip codes of residence provided by the BASES respondents and each alternative fishing site, 2) computation of average expenditures associated with different fishing modes, 3) computation of weather indices for different fishing areas and times of year, and 4) computation of catch rates associated with alternative fishing areas, fishing modes, target species and seasons. In order to do these data summaries, Thomson is supplementing the BASES data with weather and catch data from other sources. Once this task is completed the data set will be analyzed in the context of a nested multinomial logit model. (C. Thomson, FTS 893-7115)

Value of Information for Skippers in the Albacore Tuna Fishery Modelled

Industry Economist Kevin Carlson is developing a location decision model for the albacore tuna fishery using the logbook data as provided by the Multispecies Data Collection and Evaluation Program of the Pelagic Fisheries Resources Division. The average season for the U.S. North Pacific fleet consists of over 5,000 troll fishing days and about 500 separate trips over a maximum of 275 days. For the period 1975 to 1986, over 1,300 skippers participated in the logbook program and over 500 skippers submitted logbooks for two or more seasons.

The modelling consists of two parts. First, using data from 1964 to 1986, Carlson constructed fishing trip paths that yield the highest expected catch per day subject to travel constraints for a set of ports and trip lengths. Two measures of expected catch, E[catch], are used: 1) based on past fleet averages alone

without updating from current fleet performances; and 2) based on past fleet averages with updating from current fleet performance. These two measures will provide upper and lower bounds for calculating the value of information used to select a fishing site. The information available to a skipper is hypothesized to consist of four distinct sets: a) historical fleet catch rates, b) the skipper's current catch rate, c) locally shared catch rates, and d) global catch rates.

The second part of the analysis examines actual skipper behavior. Using a subset of skippers who have participated for two or more seasons, Carlson estimated the probability of choosing a particular fishing site as a function of hold capacity, days at sea, the skipper's experience, the expected catch rates for the alternative fishing sites, and the distance to those sites. Alternative fishing sites are defined to be one-degree squares. Assuming profit maximizing behavior on the part of the skippers, the site with the greatest expected profit (profit = price * E[catch] - cost * distance) will have the highest probability of being selected. Since the expectation of the catch rate will depend upon the four different sets of information, the weights of the coefficients on the expected catch rate and the distance indicate the relative values of the four different information sets in selecting fishing location. (K. Carlson, FTS 893-7148)

Pacific Mackerel Spawning Biology Reviewed

Recent investigations by scientists from the Southwest Fisheries Center and the California Department of Fish and Game (CDF&G) have shed much light on the fecundity and spawning biology of Pacific mackerel, *Scomber japonicus*. Much of that work has been reported in earlier Report of Activities, bimonthly reports, but none as yet have reached the published literature. Fishery Biologist Alec MacCall, in consultation with Terri Dickerson (CDF&G), John Hunter and Beverly Macewicz of the Coastal Fisheries Resources Division, and Michael Prager (Old Dominion University, formerly on an IPA assignment at SWFC), has compiled a review of this work for consideration at an upcoming International Council for Exploration of the Sea (ICES) Mackerel Egg and Recruitment Workshop. The physiology of the Atlantic mackerel, *Scomber scomber*, should be similar to that of the Pacific mackerel, and the comparative information should be useful to the workshop.

For many years ICES has estimated the abundance of mackerel by means of an egg production method, based on an assumption of determinate fecundity (assumption that the standing stock of oocytes at the beginning of the season represents all eggs to be spawned during the season). Abundance is estimated by the production of eggs for a season, measured by ichthyoplankton surveys, divided by the estimated seasonal production of eggs per fish. The ICES biologists have estimated the latter by the average number of "spawnable" (i.e., exceeding a minimum size)

oocytes in the gonad which are counted at the beginning of the season. The importance of the SWFC/CDF&G work is its strong evidence against determinate fecundity in this genus. In *Scomber* no reliable criteria exist at the beginning of the season to separate eggs to be spawned during the season from those which will not be spawned, so the ICES method probably is based on a false assumption. It remains to be seen whether an improved form of egg production method, such as that developed by the SWFC for the northern anchovy, can be applied to the Atlantic mackerel. (A. MacCall, FTS 893-7116)

Best Parameter Values for Anchovy Stock Synthesis Model Described

The stock synthesis model was developed by Fishery Biologist Richard Methot to analyze information on abundance of northern anchovy. This age-structured model is calibrated to spawning biomass measurements made by the egg production method and provides a comprehensive framework for interpreting diverse sources of age composition and abundance data. The model contains 58 parameters to be estimated. One category of parameters specifies the level of recruitment for the years 1959 through 1986. The other category specifies age-specific availabilty to the various types of surveys and fisheries, and environmental effects on these availabilities. In this article Methot describes some practical considerations in searching for the best parameter values.

Given the specified model structure and the current estimates of the parameters, the model calculates the log likelihood of the total available database. The model is coded in FORTRAN 77 and calculation of the log likelihood for the total database takes about 3 seconds on a PC-AT with a 10 Mhz numeric co-processor. The "best" values for these parameters are iteratively approached by numerically calculating the first and second derivatives of the log likelihood function for each parameter. This is done by temporarily changing the parameter by about 5%, and then reevaluating the likelihood function. All parameters are then simultaneously adjusted according to the negative of the ratio of the first and second derivatives for the respective parameter. Because many of the parameters strongly covary in their effect on the total log likelihood, it is potentially of value to calculate the Hessian matrix of mixed partial derivatives and to use the inverse of this matrix instead of simply using the second derivatives. However, use of the mixed partials greatly increases computation time per iteration because there are 58 first derivatives, 58 second derivatives, and 1,378 mixed partial derivatives. Each derivative requires one additional function evaluation, which consumes 3 seconds of time.

Significant savings in time are realized by the following:

Skip early part of time series when calculating the derivatives with respect to the parameters which only influence the latter portion of the data time series. This reduces the function evaluation to less than one second for the last few recruitment parameters.

Recalculate first derivatives (and adjust parameters accordingly) several times for each recalculation of the second and mixed partial derivatives; as convergence is approached the higher order derivatives typically change only a few percent.

Do not recalculate a mixed partial derivative if the current value for that derivative is near zero. The mixed partials have values between -1 and 1 after being scaled by the second derivatives. All mixed partials with absolute values greater than 0.4 are recalculated. For smaller mixed partials, the probability of being recalculated is proportional to its absolute value plus a small constant.

The value of using the mixed partial derivatives is indicated by comparing the time course of two runs of the model, one using the mixed partials and one using only the second derivatives (Table 1). Both runs started with the same initial

Table 1. Time course of two model runs, one with and one without using the matrix of mixed partial derivatives. Each cycle of a run indicates increasingly tight convergence, e.g. change of 1,000 in the first cycle, 100 in the second cycle. Final convergence occurs when a cycle produces a change of less than 1.0. Each recalculation of the first derivatives is used to adjust the parameters towards the values which maximize the likelihood.

	With mixed partial derivatives				
Cycle no.	Likelihood value	Elapsed time (hr:min)	Number of derivative calculations		
			Second	Mixed	First
Start	-1575	0:00			
1	-651	0:13	1	0	1
2	-390	2:10	2	2	4
3	-276.5	5:20	5	5	15
4	-275.4	5:54	1	1	3
5	-274.5	6:36	1	1	3

Without mixed partial derivatives					
Cycle no.	Likelihood value	Elapsed time (hr:min)	Number of calculations		
			Second	Mixed	First
Start	-1575	0:00			
1	-651	0:13	1	0	1
2	-427	0:38	2	0	4
3	-396	1:02	2	0	6
4	-279.4	4:14	13	0	49
5	-279.0	4:25	1	0	2

parameter values and both ended at nearly indistinguishable points. The run with the mixed partials took more time, but seemed to approach the maximum likelihood point more strongly. The 58 parameter model converged with only 26 recalculations of the first derivatives. Without the information in the matrix of mixed partials, the model only slowly approached the optimum. In addition, the mixed partials indicate parameters which are strongly correlated thus may guide reparameterization of the model. The inverse of the mixed partial matrix is the first step towards calculating variance estimates for the parameters.

Future work on the anchovy version of the stock synthesis model will be conducted by Drs. Nancy Lo and Alec MacCall of the Coastal Fisheries Resources Division. Methot has transferred to the Resource Ecology and Fisheries Management Division of the Northwest and Alaska Fisheries Center in Seattle, Washington, where he will be working on stock assessment and management of west coast groundfish species. In this new position, Methot hopes to utilize similar modeling techniques to investigate historical abundance and mortality for these species. (A. MacCall, FTS 893-7116)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION
La Jolla, California

FISHERY DEPENDENT DATA PROGRAM

Seasonal Changes in Dolphin Distribution Indicated by Research Vessel Sightings

Fishery Biologist Stephen Reilly has been working on detecting seasonal changes in the distribution of dolphins throughout their overall range in the eastern tropical Pacific. Until now our understanding of the distribution of dolphins has been based largely on data collected from research vessels during northern winters because the data collected during the summer months have been too sparse to allow comparison. However, as a result of the dolphin assessment cruises in the eastern tropical Pacific from August through November 1986 and August through November 1987, as well as data from a research cruise conducted in the summer of 1982, Reilly has been able to make the comparison for the first time.

The data collected on research vessels during the winter show an extension along 10°N, although it is a very weak one, and higher relative densities occur to the south (Figure 1). In

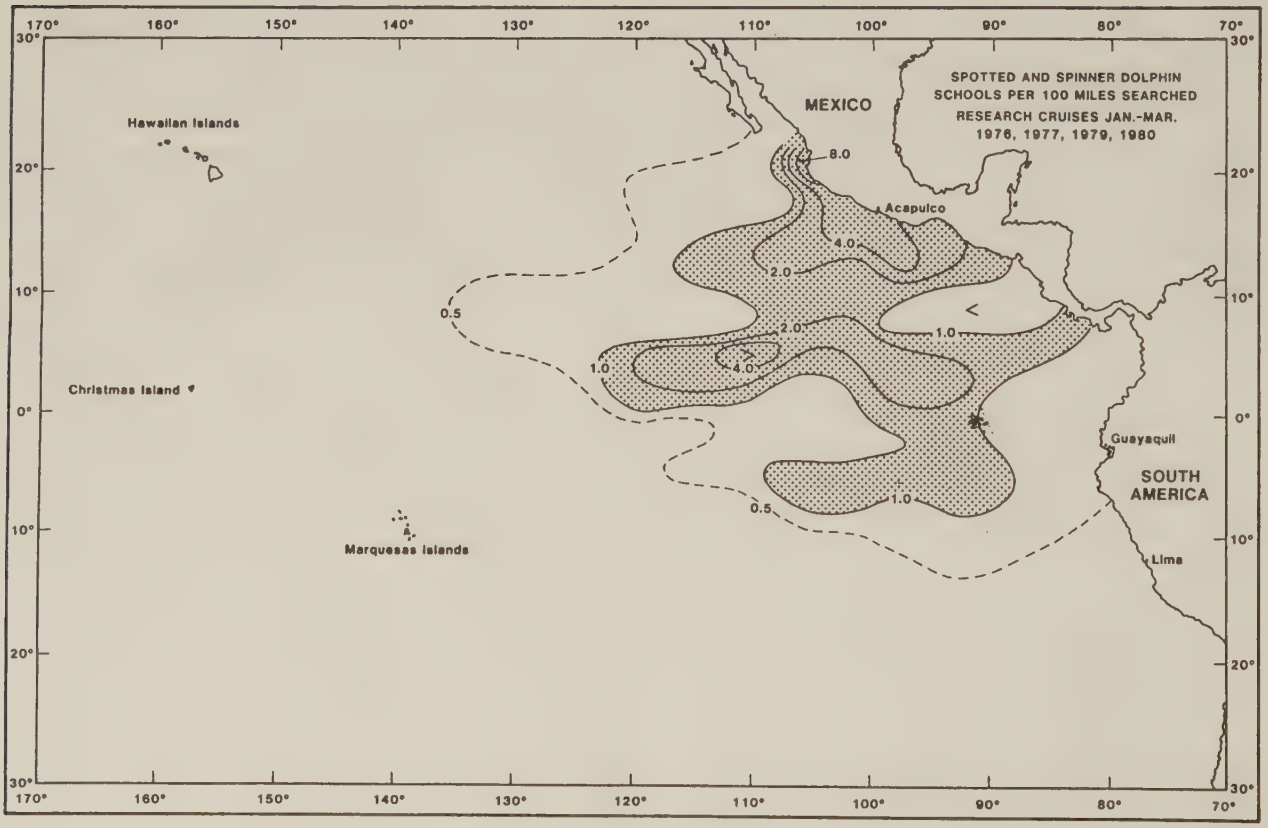


Figure 1. Winter distribution of spotted and spinner dolphins, adapted from Au and Perryman, 1985.

contrast, overall summaries of all sighting and collection localities (Perrin et al., 1985, NOAA Tech. Rep., NMFS 28), which are predominantly data collected by observers on tuna vessels, show a marked, high-density extension of dolphin distribution westward along 10°N to beyond 150°W. Some possible hypotheses to explain this difference are that the predominantly tuna vessel data sighting summaries are biased, the research vessel analyses are biased, or the westward extension of distribution is in fact a seasonal feature which is not prominent in the northern winter.

The data from the summer 1982 cruise and the August-November 1986 cruise, which was conducted with two NOAA ships, together provide approximately 11 ship months of sighting effort. To compare that data with the data from the winter and early spring, Reilly plotted the summer and fall data as schools sighted per 100 miles of searching in Beaufort sea states of 4 or less. These encounter rates were then smoothed and interpolated, and contour plots were drawn. Figure 2 shows the contour plot for

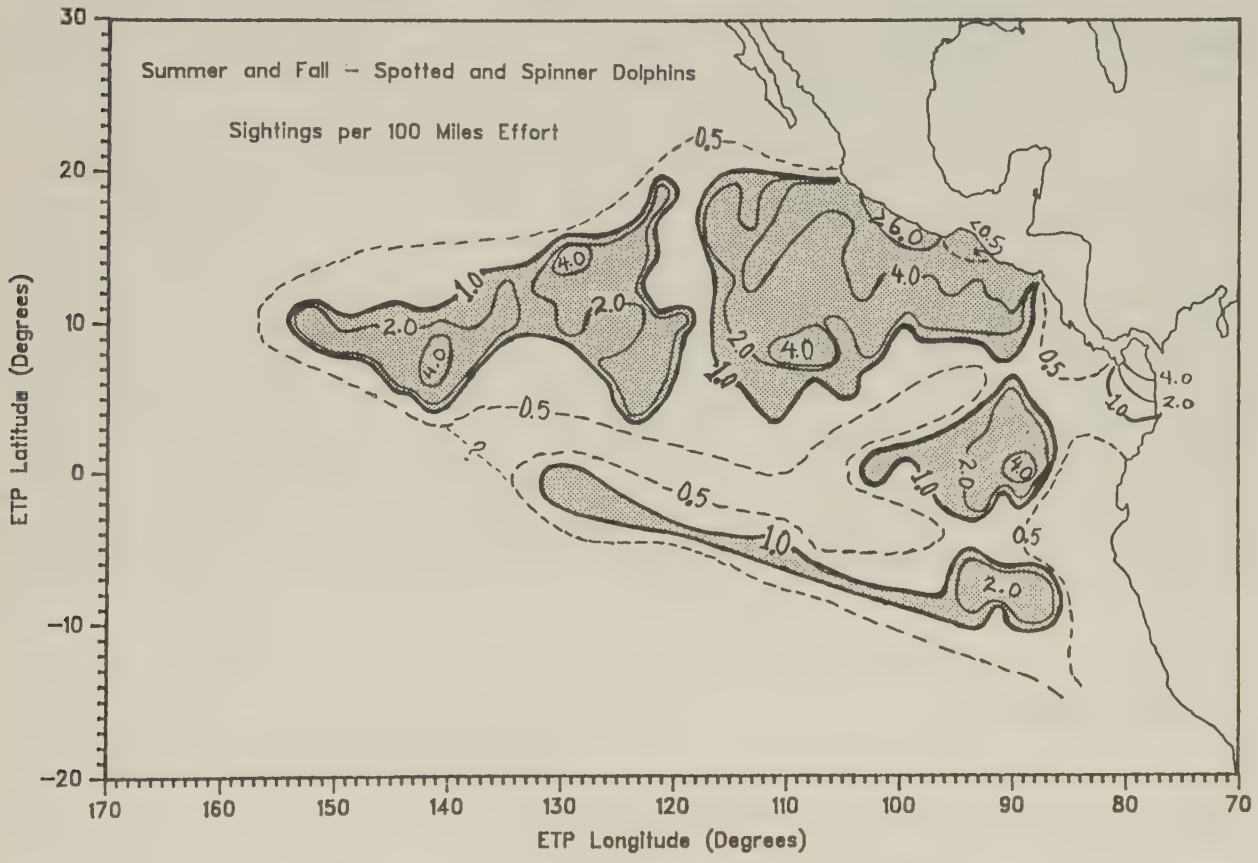


Figure 2. Summer-fall distribution of spotted and spinner dolphins, from 1982 and 1986 research vessel surveys.

spotted and spinner schools. In contrast to Figure 1, there is a substantial extension of distribution to the west along the 10°N axis. This strongly suggests that the density of dolphin schools along 10°N west of about 120°W changes seasonally--with the density reduced in the winter and increased in the summer. Both common and striped dolphins showed a similar westward shift in

distribution in the summer-fall months, although the shift is not as pronounced as seen here for spotted and spinner dolphins.

This seasonal pattern coincides with, if it is not in fact causally related to, seasonal changes in thermocline topography. There is a prominent ridge in the thermocline along 10°N, caused by a divergence at the boundary between the westward-flowing North Equatorial Current and eastward flowing Equatorial Countercurrent. The amount of uplifting or "ridging" of the thermocline there varies seasonally with the variation in the currents, especially the Countercurrent, such that the ridge is closer to the surface in the late summer-autumn months, and deeper in the late winter-spring months. As the thermocline is brought closer to the surface, more nutrient rich water is brought into the euphotic zone, and productivity is enhanced. It seems reasonable to speculate that the seasonal increase in dolphin density west of 120°W along 10°N is in response to this increase in biological productivity. There is undoubtedly a time lag between the onset of increased productivity and the resultant increase in potential forage for dolphins, although at this point there are not enough data to obtain a better resolution of the annual timing of changes.

As the dolphin assessment cruises continue for the next 3 years, further data will allow Reilly to examine inter-annual variability in the patterns of summer distribution, and provide a better indication of the robustness of our current understanding of intra-annual changes. Also, as part of the dolphin assessment cruises, detailed studies of the physical habitat, and some aspects of the biological habitat of the cetaceans are being conducted. These studies are being done jointly with researchers from NOAA's Atlantic Oceanographic and Meteorological Laboratory and other institutions. They are now examining mesoscale patterns of variability in dolphin distribution and in the environment, in hopes of gaining a better understanding of the smaller scale pieces that combine to make up the regional patterns, such as the seasonality described here. (S. Reilly, FTS 893-7164)

BIOLOGY PROGRAM

Fishery Biologist to Give Talk on MtDNA

Fishery Biologist Dr. Andrew Dizon has been invited to present a paper on the utility of mitochondrial DNA (mtDNA) to reveal gene flow in marine systems during a seminar sponsored by the American Association for the Advancement of Science (AAAS) and the National Science Foundation. The seminar will be held in Boston between February 12 and 14; it is organized by Drs. Kenneth Sherman, Northeast Fisheries Center; J. P. Grassle, Marine Biological Laboratories, Woods Hole; and Barry D. Gold, AAAS. The seminar will feature talks on recruitment, dispersal,

and gene-flow research; on current studies in fluctuations in marine organism abundance (relating to demography and physical oceanography); and on new approaches for integrating research findings to address regional community processes.

Dizon will review recent studies on the rapidly evolving, maternally-inherited mitochondrial DNA(mtDNA) nucleon applied to fishery problems. In contrast to freshwater and terrestrial environments, in the pelagic marine environment physical barriers are probably less effective, leading to higher exchange rates between populations or breeding units at or below the species level variously called geographic forms, sub-species, stocks, races, etc. Consequently, in the absence of intense differential social or ecological selection pressures, genetic differences accumulate more slowly, if at all, between them. Thus, in general, population studies of closely related marine taxa require sensitive techniques that can detect small degrees of genetic heterogeneity. mtDNA would seem to be ideal because it evolves 5 to 10 times faster than nuclear DNA.

The title of Dizon's presentation is "Mitochondrial DNA diversity: Revealing gene flow among species, populations, and schools in the marine environment." (A. Dizon, FTS 893-7088)

HONOLULU LABORATORY
Honolulu, Hawaii

PELAGIC RESOURCES INVESTIGATION

Depth Data on Striped Marlin Digitized

Fishery Biologist Richard W. Brill recently completed digitizing the data on swimming depth of striped marlin, *Tetrapturus audax*, in support of a joint project conducted by David Holts of the Pelagic Fishery Resources Division, and Dennis Bedford of the California Department of Fish and Game on the behavior of swordfish and striped marlin. Holts and Bedford used depth-sensitive, ultrasonic transmitters and an audiotape data recording system to record the horizontal and vertical movements of striped marlin off the California coast. The system is similar to that used in the ongoing tuna tracking project of the Honolulu Laboratory and University of Hawaii (UH) Sea Grant Program. Meetings between Brill and Holts in October 1987 determined that digitizing the data tapes at the Honolulu Laboratory via a computer hardware and software system developed by Brill over the past several years would be more cost effective than developing a separate system in La Jolla.

The depth data were digitized directly from the audiotape record (e.g. Figure 1), and then redigitized by a computer graphics tablet (e.g. Figure 2). The end result was depth records at about 10-sec intervals for the duration of the track.

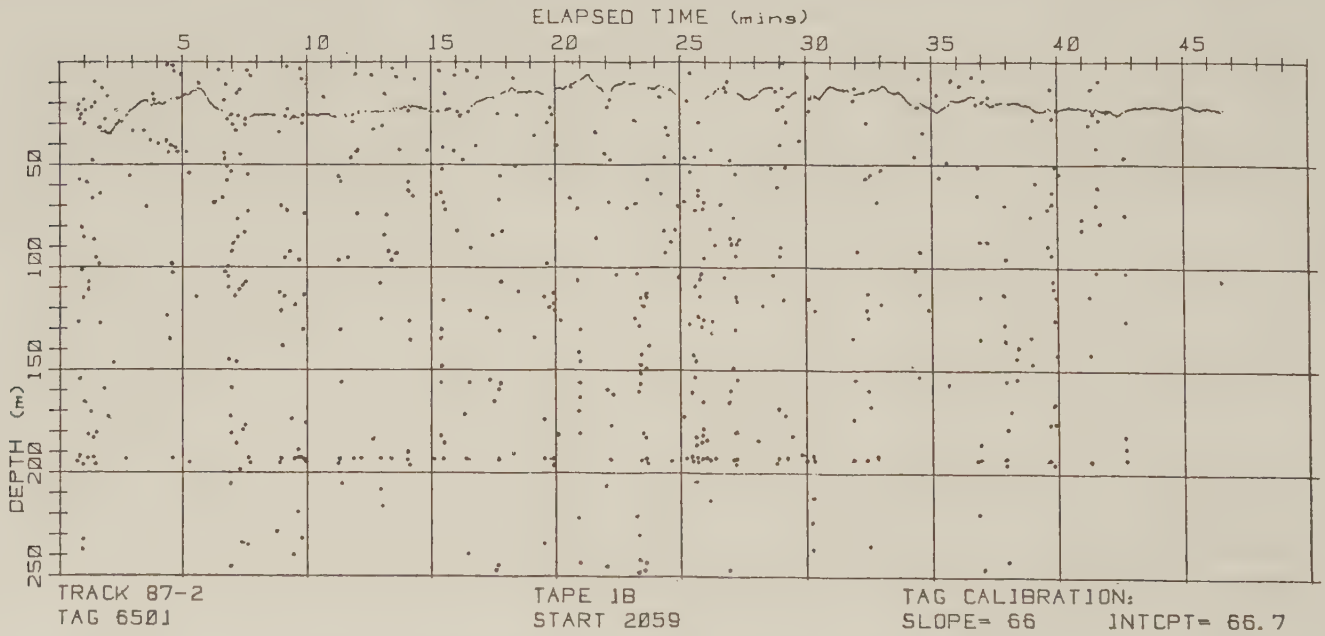


Figure 1. Plot of swimming depth of striped marlin. Data were plotted directly from audiotape record of the depth-sensitive transmitter's pulsed output. The track, obtained off southern California, was conducted by Dave Holts of the SWFC, La Jolla.

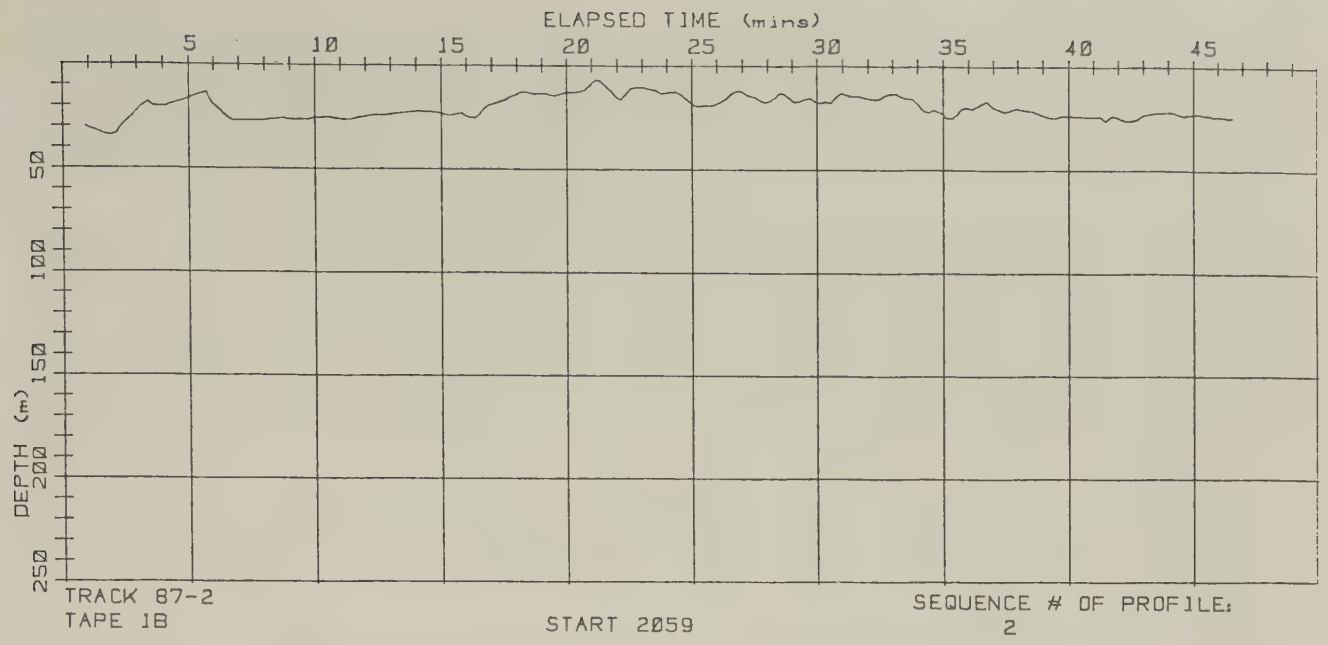


Figure 2. Plot of swimming depth of striped marlin after data record was redigitized by a computer graphics tablet. Tracing the original depth record on the graphics tablet removed all spurious data points and filled in short interval gaps in the data. The result is a nearly continuous record of the fish's swimming depth.

These records were then summarized by using a program developed by Brill and by using XBT data, to provide information on the amount of time spent at various depths and at specific water temperatures during the track.

Copies of the software, written for use on IBM or IBM-compatible microcomputers, are available from Brill. (R. Brill (808) 943-1266)

MARINE MAMMALS AND ENDANGERED SPECIES PROGRAM

Marine Turtles Assessed at Johnston Atoll

The status of the green turtle, *Chelonia mydas*, at Johnston Atoll was assessed November 23 to December 7, 1987, by scientists of the Marine Mammals and Endangered Species Program. The atoll, located about 700 nmi southwest of Honolulu, is home to a population of green turtles that forage there on several species of marine algae. It also is a munitions storage site, and construction of a large disposal facility for the chemicals is in progress. During the planning phase for the disposal facility in 1983, the turtle population has been assessed periodically because of potential effects on the turtle population or their nearshore foraging grounds. Funding for this work has been provided by the U.S. Army Corps of Engineers, Pacific Ocean Division.

Zoologist George H. Balazs, who led the team of Honolulu Laboratory scientists, reported that censuses of the foraging area from shore and boat indicated that turtles continue to occur in concentrated numbers along the south shore of Johnston Island, the major islet within the atoll. Up to 20 turtles were sighted during peak afternoon foraging hours. Nevertheless, nets deployed to capture turtles for tagging and measuring had a very low catch rate: Only two animals were captured. The reduced catch rate may have been related to any of several factors, such as altered foraging behavior in which *Caulerpa* sp. growing between coral heads was being eaten more than *Bryopsis* sp. on top of the coral heads; large northwest swells and high winds in the foraging area; or a high proportion of immature turtles, which are less likely to become caught in the nets.

One of the turtles captured was originally tagged at Johnston Island in 1983 as part of the initial assessment. It represents the first recapture of a tagged turtle at Johnston, although two other turtles tagged as part of the 1983 study have been recovered at French Frigate Shoals. The turtle recaptured at Johnston had grown from 57.4 to 68.5 cm in carapace length, an increase of about 2.7 cm/yr. Its growth rate is similar to that of turtles resident to foraging pastures in the main Hawaiian Islands. (G. Balazs (808) 943-1240)

INSULAR RESOURCES INVESTIGATION

Study Completed on Pelagic Biogeography of the Armorhead in the North Pacific

In a recently completed study, George W. Boehlert, Program Leader of the Insular Resources Investigation, and Dr. Takashi Sasaki of the Far Seas Fisheries Research Laboratory in Shimizu, Japan, compiled all available data on the distribution of the pelagic armorhead, *Pseudopentaceros wheeleri*, to document its biogeography and better understand its relationship to oceanographic conditions. Their study is part of ongoing research by the Honolulu Laboratory on seamount resources at the Southeast Hancock Seamount, where about 10% of the stock of armorhead occurred before a significant stock decline. The decline was due to a major fishery in 1968-77, during which Soviet and Japanese fisheries took about 1 million metric tons. A major effort of the program is to document the recovery of the armorhead stock during a 6-yr cessation of foreign fishing effort, while other efforts focus on the biology of pelagic armorhead.

Boehlert and Sasaki described the distributional patterns of armorhead in the North Pacific, using over 30 yr of published and unpublished records. The pelagic armorhead occurs widely in the North Pacific Ocean and is the dominant species on the seamounts of the central North Pacific. Its main reproductive

populations are on the southern Emperor-northern Hawaiian Ridge seamounts between lat. 29° and 35°N. Most pelagic specimens have been captured in the subarctic water mass in the northeast Pacific, although, on relatively rare occasions, benthic specimens have been taken from Japan, the Hawaiian Archipelago, and the west coast of North America.

In the migratory path for the majority of the population, young fish apparently move northeast from the seamounts and are soon located in the subarctic region (see Figure 3), and younger specimens are captured farther north (region B) than are older fish (region C). The exact pattern of return movement to the seamounts remains unknown, as does the mechanism for locating these very small pinnacles in the open ocean. Research on age and growth (using otoliths) by Fishery Biologist James H. Uchiyama and Research Assistant Jeffrey D. Sampaga has shown that the period between spawning and recruitment to the seamounts is apparently between 1.5 and 2.5 yr, suggesting an extended pelagic existence.

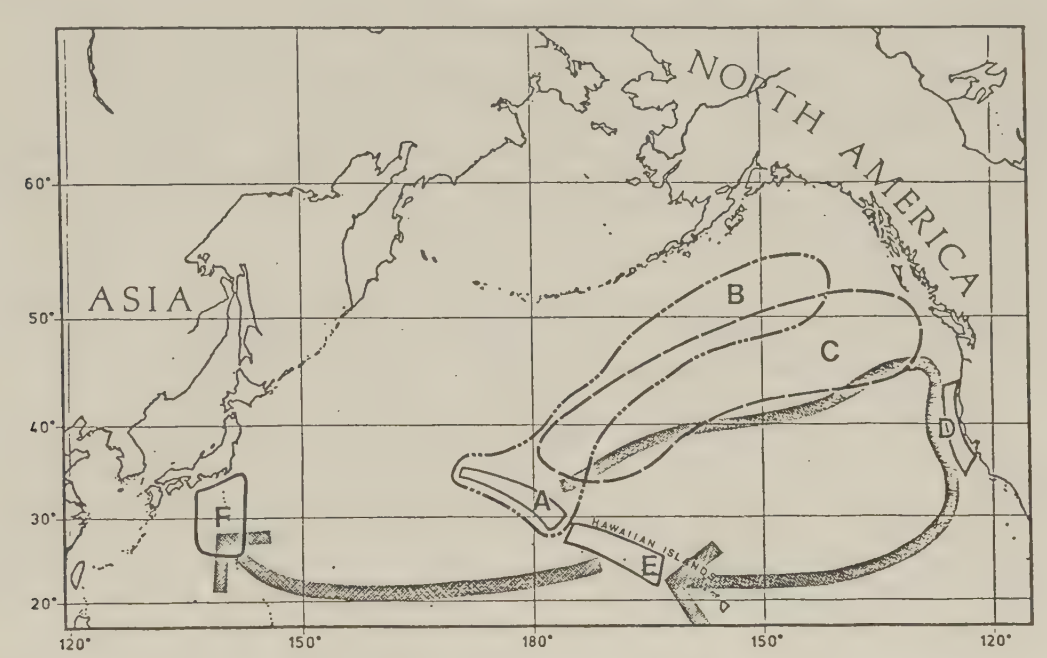


Figure 3. Distributions of benthic and pelagic specimens of armorhead, *Pseudopentaceros wheeleri*, by age group, with possible patterns of movement. Region A represents the major spawning area; regions B and C represents areas in which <1-year-olds and 1- to 2-yr-olds respectively, have been captured; and regions D, E, and F represent locations of benthic collections from California, the Hawaiian Islands, and Japan, respectively. Arrows represent possible patterns of population movement.

Seasonality of recruitment seems to vary interannually, according to the study by Boehlert and Sasaki. Monthly data on condition factor, an index of "fatness," from the Japanese

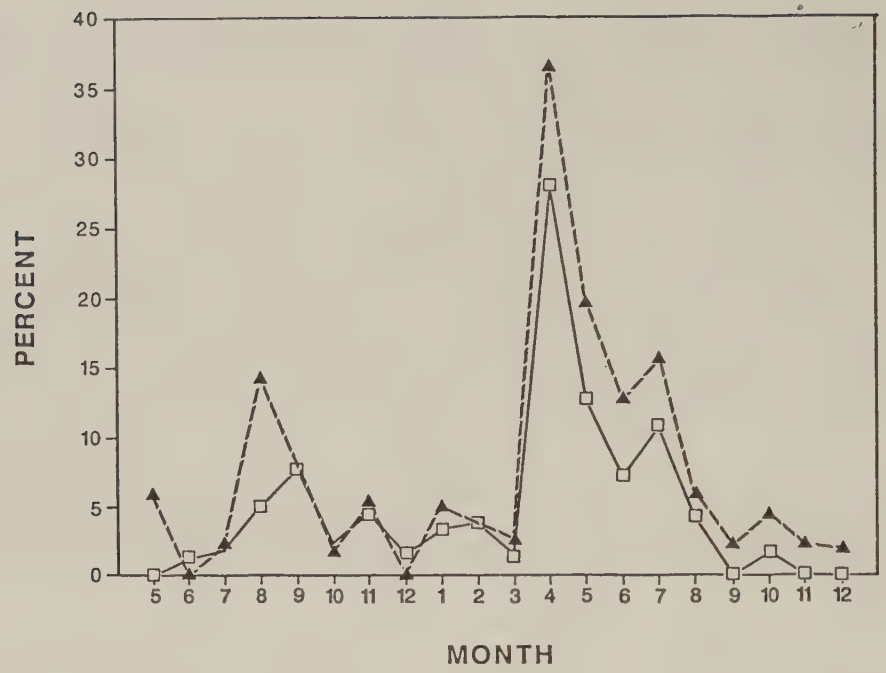


Figure 4. Seasonality of the proportion of armorhead, *Pseudopentaceros wheeleri*, with condition factors ≥2.2, from four southern seamounts (Southeast Hancock, Northwest Hancock, C-H, and Colahan) for 1972-73. Squares equal males (N = 2,104); triangles equal females (N = 1,704).

fishery for 1972-73 (Figure 4) revealed that most recruitment in 1972 occurred in August, but in 1973, it began in April and apparently continued through August. Data on condition factor rather than length frequency are used because the fish do not grow after reaching the seamount and, instead, change morphologically from fat to lean--a transition described in detail by Fishery Biologist Robert L. Humphreys, Jr. Research on the more recent recruitment patterns, based upon research cruise data of the Honolulu Laboratory, are underway. (G. Boehlert (808) 943-1234)

Cooperative Cruise Surveyed Penguin Bank

A joint research cruise involving personnel from the Honolulu Laboratory and the UH Sea Grant was conducted aboard the NOAA Ship *Townsend Cromwell* at Penguin Bank from October 29 through November 6 and from November 12 to 20. Penguin Bank is a flattop, shelflike rise extending some 55 km west from the Island of Molokai. The bank encompasses an area of some 830 km^2 at depths from 45 to 55 m. Penguin Bank is the site of an important local fishery for deep-sea bottom fishes, primarily snappers and groupers. Bottom fishes have been commercially harvested for some time, but little is known of the factors important in productivity of the resource. The joint cruise was designed to learn about these factors.

On the first leg of the cruise, Chief Scientist Paul M. Shiota and UH Researcher Dr. James D. Parrish led efforts to collect bottom fish specimens for studies on feeding periodicity and prey type. Five bottom longline and 30 deep-sea handline stations were conducted over the summit and slopes of Penguin Bank. These operations yielded 209 specimens representing 10 bottom fish species of commercial importance. Although forage items were frequently recovered, efforts to increase retention of gut contents by slowing the retrieval rate proved unsuccessful. Hydroacoustic surveys were conducted prior to fishing operations to assess the relationship between hydroacoustic signal patterns and actual fish presence. Marine mammal surveys conducted by personnel from the Marine Mammals and Endangered Species Program yielded 15 sightings of cetaceans on the surface around Penguin Bank.

During the second leg, Chief Scientist Humphreys and UH Researcher Catherine R. Agegian led an investigation to assess the extent to which Penguin Bank influences the physical and chemical properties of the overlying seawater environment. Information on current flow over the bank was collected via subsurface current drogue and Acoustic Doppler Current Profiler operations. Preliminary results indicate that tidal currents primarily direct the subsurface movement of water over the bank. A moored sediment trap array was deployed over the north slope of Penguin Bank to collect information on the vertical flux of organic and carbonate particles in the upper 400 m of the water column. Water samples covering the upper 400 m were collected in conjunction with 21 current-temperature-depth (CTD) casts taken at one site over the south slope of the bank. These casts and water sample collections were conducted over a single 63-h period to determine the extent to which the following vary with respect to tidal state: temperature, salinity, dissolved oxygen, alkalinity, nutrients, pH, chlorophyll, and particulates.

In addition, 23 CTD casts along with depth-stratified water samples were conducted at 4-h intervals along the drift track of the current drogue. Results from these data may indicate the extent to which water over the bank undergoes temporal changes in physical and chemical properties. Twenty bottom samples also were collected from various sites on the summit and slopes for analysis of mineral content. (J. Polovina (808) 943-1218)

PACIFIC FISHERIES ENVIRONMENTAL GROUP
Monterey, California

Information Document on Pacific Albacore Completed

The Albacore Task Force, which comprises Richard Parrish of PFEG, Norman Bartoo and Pierre Kleiber of the Pelagic Fishery Resources Division, Sam Herrick and Michael Laurs of the Coastal Fisheries Resources Division, and Jerry Wetherall of the Honolulu Laboratory, has recently completed an Albacore Management Information Document, which describes the current knowledge of the North Pacific albacore resource, the present status of the resource, and the status of the fishery.

The Albacore Task Force was organized in conjunction with a multiyear research, evaluation and development program for Pacific albacore which began in 1983. The albacore program was the first NMFS program that was designed through an interactive planning process in which a constituent group, who represented a wide range of public interests related to albacore, developed the strategic plan for the program. This plan was then translated into an operational plan by the Albacore Task Force, which included technical personnel from the Southwest Region and four of the divisions of the Southwest Fisheries Center. Below is a summary of the information document.

Historically, the U.S. albacore fishery has marketed its product almost exclusively to canneries. The distant water nature of the fishery, the reliance on the cannery market, and the recent great reduction in local canning of tuna resulted in a situation where it became very difficult for the fishery to market as much albacore as it could land. The principal mechanism used by NMFS to assist the albacore fishery in regaining economic stability has been through grants to industry sponsored programs. Twelve Saltonstall-Kennedy grants, which were administered by staff of the Southwest Region, were used to assist in the development of new markets for albacore. Four of these grants concerned market development ($279,350), three were concerned with onboard processing methodology and new product development of albacore ($124,400), and five were for albacore fishery development ($433,000). In addition to the S-K grants, NMFS personnel prepared four economic analyses concerning the albacore fishery. Three of these dealt with the commercial fishery and one with the recreational fishery.

Annual albacore catches (since 1952) for the three major North Pacific fisheries (i.e. the United States surface fishery and the Japanese baitboat and longline fisheries) show that the United States fishery averaged 18,414 MT or 25% of the total annual catch, while the Japanese baitboat fishery averaged 36,000 MT (48%) and the Japanese longline fishery averaged 17,273 MT or 23% (Figures 1 and 2). On average it took 1.63 fishing days in the U.S. jigboat fishery, 0.189 fishing days in the Japanese longline fishery to catch one metric ton of albacore.

A significant characteristic of the North American fishery is the wide variation in the geographical locations of the most productive fishing grounds. A large proportion of this variability is at the decade rather than the inter-year time sale. For example, catches off California dominated the fishery prior to the 1930's and from about 1957 to 1965; catches from Baja California were large from about 1948 to 1956; and those from Oregon and Washington were dominant from during the late 1930's to mid 1940's and from about 1966 to 1975. Catches have been variable throughout the time series with an apparent downward trend since the mid 1970's. Effort levels for the jigboat fishery indicate a peak in the early 1970's, a period of high prices which followed a number of years of high catch rates, with decreasing effort since then (Figure 3). A CPUE decline from about 120 fish/day in the late 1960's to about 40 fish/day in 1980 precedes the decline in effort and catches. More recently the CPUE has increased to near 1960's levels.

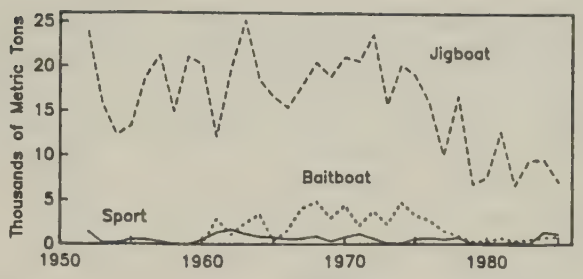


Figure 1. United States albacore catch by gear type.

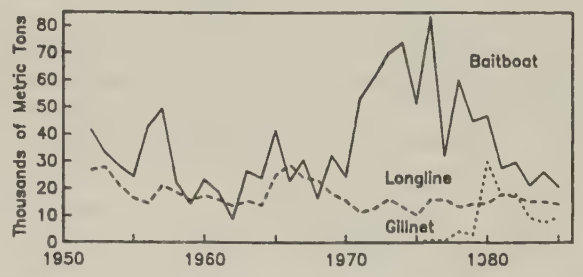


Figure 2. Japanese albacore catch by gear type.

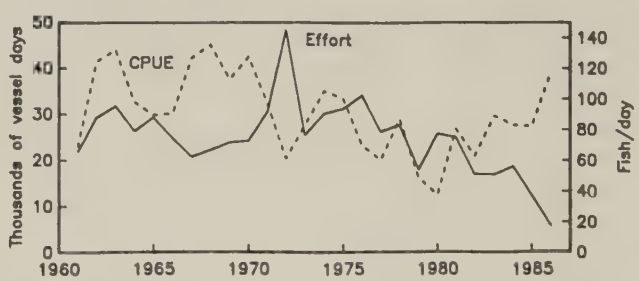


Figure 3. United States albacore fishing effort and CPUE.

The exploitation of albacore in the North Pacific is extremely patchy when viewed against their complete life history. The immature fish are harvested almost exclusively during the spring to fall, whereas the mature fish are harvested essentially only in the winter. The immature fish, ages 2 to 5, are primarily harvested in association with frontal formations in the northern portion of the North Pacific Gyre; however, the age structure of the catch is very different in the Kuroshio, Kuroshio Extension and California Current regions. Mature fish are primarily harvested in the western half of the Pacific at latitudes between 25° and 35° north; however, the breeding adults are almost unexploited.

A significant proportion of recent NMFS albacore research has centered around the development of a simulation model of the North Pacific albacore population and fisheries. The international North Pacific albacore fishery is carried out by

fisheries utilizing different gear types. Each fishery has a different geographical range and seasonality and each fishery exploits a different size distribution of albacore. The model therefore requires resolution by gear type, area, season, and fish size. The first use of the model was to study the interaction between the three fishing fleets. The model simulated recruitment, growth, movement, natural mortality and harvest of albacore by three fishing fleets: the Japanese baitboat fleet, the Japanese longline fleet, and the United States jig fleet. At the current level of exploitation, the largest interaction modeled was an 8% loss of longline catch due to a doubling of baitboat effort, suggesting that the population is only moderately exploited.

The stock structure of albacore in the North Pacific was one of the most significant areas for research in the strategic plan. State of the art population genetics analyses, utilizing mitochondrial DNA, demonstrate that albacore from the North Pacific are genetically indistinguishable from those off of South Africa with presently available methodology. This implies that it is possible that there is only a single stock of albacore in the entire Pacific. Conversely, it does not rule out the possibility that there is more than one fishery stock in the North Pacific. Results from a number of studies suggest that there are two subgroups of albacore in the North Pacific. These subgroups appear to have different migratory patterns, modal sizes in the U.S. fishery, growth rates, and birth months.

The presently available information suggests that the most likely situation is that there are either one or two stocks of albacore in the North Pacific. If there is only one stock it spawns year round, and fish spawned in the summer, more northerly spawning grounds tend to have a more northerly distribution as juveniles than those spawned in the winter, more southerly spawning grounds. If there are two stocks, one spawns in the summer and the other in the winter, and the two stocks have different geographical distributions.

If there is only one stock available, evidence suggests that the stock has been moderately exploited and that the population and its recruitment have been remarkably stable. Simulations with the albacore model, made under the assumption of a single stock, show very little interaction between the three major fisheries and suggest that the stock is not heavily exploited. The CPUE's of the major fisheries vary by factors of about 2.6 in the two Japanese fisheries and 3.8 in the American fishery, and there is a significant correlation (0.01%) between the CPUE's in the Japanese and American surface fisheries (r=0.554). However, the American fishery is much more remarkable for its geographical variation than its interyear variation in catch or CPUE. Finally, the size composition in the longline catches in the main spawning grounds where the largest albacore are taken have remained nearly constant from 1965 to 1981 also suggesting that the exploitation level has not been high. However, fishing effort and catch in both the Japanese and American surface

fisheries are presently about one quarter of their peaks. In both fisheries the period of decline follows extended periods of reduced CPUE, and economics cannot therefore be blamed for all of the decreases in effort and landings. In contrast, recent landings and fishing effort in the longline fishery have been relatively constant.

If there are two stocks in the North Pacific either the recruitments or the migrations of these stocks to the California Current region must be extremely variable. The relative stability of the Japanese fisheries in comparison to the fishery in the northern portion of the California Current region would imply the latter. In addition the pattern of landings in the California Current region (i.e. multiyear series of northern or southern dominance) implies that the variations in the two stocks are negatively correlated. The two-stock concept also suggests that the northern stock provides the major component of the North Pacific landings as it is presumably the principal stock in the Japanese surface fishery. However, both stocks have about the same tag recovery rates (5%), and therefore the same exploitation rates, in the adult habitat (i.e. in the Japanese longline fishery).

A second difficulty in evaluating the status of the North Pacific albacore resource is the general lack of information on the spawning population. It is extremely difficult for U.S. researchers to develop this information due to the fact that the mature segment of the population is not harvested by U.S. fishermen, and the adult habitat lies outside of the geographical regions normally surveyed by U.S. fishery research vessels.

The Albacore Task Force made the following recommendations:

1. The United States should not attempt to manage the North Pacific albacore fishery unilaterally.

2. The United States should develop a strategy regarding future international monitoring, research and management of highly migratory fishes which are not subject to national jurisdiction. (R. Parrish (408) 646-3311)

PELAGIC FISHERY RESOURCES DIVISION
La Jolla, California

FISHERY MONITORING AND EVALUATION PROGRAM

Tuna Newsletter Gets New Design and Expanded Format

The first issue of the newly designed Tuna Newsletter was produced and distributed in November. The Tuna Newsletter is now a joint project of staff of the Southwest Fisheries Center and the Southwest Region.

Until the reorganization of tuna research at the Center, the Tuna Newsletter had been edited by Lillian Vlymen of the Center Director's staff. Beginning in 1972, Vlymen assembled 86 issues. In 1986 the Newsletter became the responsibility of the staff of the Pelagic Fisheries Resources Division when the Southwest Fisheries Center became responsible for all NMFS tuna-related research for the Indian Ocean, western and central Pacific Ocean, and the eastern tropical Pacific. Among the Center's strategic goals is the operation of a tuna data information system, of which the Tuna Newsletter is one of the principal products. The tuna data information system was created for use by researchers, U.S. government officials, and the U.S. tuna industry.

The format of the Tuna Newsletter has been expanded to include accounts of research in progress on tunas at the Center laboratories in La Jolla and Honolulu. The Newsletter also contains information on trends in world fisheries prepared and distributed by the Office of International Fisheries Affairs and other NMFS offices. The information focuses on topics of interest to the tuna industry throughout the world. The Newsletter is produced by Wes Parks, Pat Donley, Jean Davis, and Ken Raymond. (W. Parks, FTS 893-7074)

Recommendations of the Tenth North Pacific Albacore Workshop Published

The Tenth North Pacific Albacore Workshop, held in Shimizu, Japan, in August 1987 and attended by Norman Bartoo, Michael Laurs, and Jerry Wetherall of the Center, produced a number of recommendations documented in the recently printed workshop report. The recommendations were grouped into four areas: Improvement in Statistics, Stock Assessment, Biology, Ecology and Stock Structure, and Ocean Environment.

To improve statistics, the participants recommended that catch, effort and size composition data for albacore caught by Japanese drift gillnet fisheries should be obtained. Efforts to secure these data have been underway and should be continued. Statistics on the amount of fresh albacore that is consumed and albacore that is marketed directly in the U.S. should be

collected. Fishery statistics for albacore caught by the Taiwanese squid driftnet fishery should be investigated and data secured. Any information on Korean tuna fisheries in the North Pacific Ocean should be obtained; there is virtually no information on these fisheries. Catch and fishing effort statistics from all participants should continue to be presented on a timely basis.

For stock assessment, the participants made four recommendations. Production model and yield-per-recruit and basic analyses should be continued and reported. An updated spawner-recruit analysis for the stock(s) should be undertaken and modeling of early life history stages (pre-recruit) is encouraged. Simulation model analyses and alternative assessment techniques should be continued to test hypotheses critical to other analyses. Assessments should take in the possibility of a geographically divided fishery stock in the North Pacific.

In the area of biology, ecology and stock structure, the participants recommended that age and growth analysis should continue based on otolith, tag returns and length-frequency data. Special attention should be given to resolving differences between growth models based on otoliths and tag returns. A migration model by age that incorporates all tagging data and other appropriate data available for the North Pacific albacore resource should be developed. A Japanese scientist(s) should work with U.S. scientists in the U.S. to accomplish this task. Spawning areas and seasons should be identified and reported. Juvenile sampling studies at sea are encouraged as well as histological studies of maturity and sex ratios in adult fish. Physiology studies and further work with ultrasonic tracking should be undertaken as a means of improving understanding of albacore behavior and definition of albacore habitat. Progress in the development in the U.S. of the "archival" tag should be monitored and the use of the "archival" tag to investigate albacore biology should be encouraged. Tagging of albacore in the central and western Pacific should be continued and expanded. Emphasis should be placed on obtaining information for 1- and 2-year-old fish as well as for mature fish of 6 years and older.

In managing the ocean environment, a joint Japan/U.S. effort should be conducted to determine oceanographic and other natural mechanisms that affect the migration patterns of albacore. This work should be undertaken when the albacore migration by age model is developed. Since the oceanographic conditions in the western Pacific, notably in the Kuroshio and Kuroshio Extension regions, appear to play key roles in affecting albacore migratory patterns, a U.S. scientist(s) should work with Japanese scientists in Japan to accomplish this task. Oceanographic studies to identify and quantify key habitat processes affecting albacore fisheries should be continued for input into simulation and ecology studies. Extended application of satellite remote sensing data to fisheries research application should be continued.

Participants of the Tenth North Pacific Albacore Workshop (from right to left): Norman Bartoo, SWFC; Michael Laurs, SWFC; Jerry Wetherall, SWFC; Keisuke Mizuno, Far Seas Fisheries Research Laboratory (FSFRL), Shimizu, Japan; You Watanabe, Japan Marine Fishery Resource Research Center, Tokyo, Japan; Toshio Shiohama, FSFRL; Tamotsu Yonemori, FSFRL; Hsi-Chiang Liu, National Taiwan University, Taipei, Taiwan; Naozumi Miyabe, FSFRL; Ziro Suzuki, FSFRL; Susumu Kume, Tokai Regional Fisheries Research Laboratory, Tokyo, Japan.

The participants in the workshop are currently planning the best way of accomplishing the recommendations in the next 2 years. (N. Bartoo, FTS 893-7073)

TIBURON LABORATORY
Tiburon, California

GROUNDFISH COMMUNITIES INVESTIGATION

Studies Continue to Demonstrate Substantial Year-to-Year Variability in Recruitment of Rockfishes

Strong recruitment this year by several species of rockfishes (*Sebastes* spp.) in northern California coastal habitats (Figure 1) demonstrates substantial year-to-year variability. In studies by the staff of the Groundfish Communities Investigation, the total number (all species) of first-year juvenile rockfish in both *in situ* visual counts and in the gut contents of predators has been greater this year than any other year since assessments began in 1983.

Figure 1. Juvenile rockfishes (most of them blue rockfish, *Sebastes mystinus*) in a Mendocino kelp forest.

The visual counts by Fishery Biologists Dan Howard and Tony Chess (Table 1) found the same three species predominant in the nearshore habitats as in previous years--the blue rockfish (*S. mystinus*), the black rockfish (*S. melanops*) and the yellowtail rockfish (*S. flavidus*). The greater total number of juveniles this year, however, resulted from exceptionally strong recruitment by the blue rockfish. There were actually fewer yellowtail rockfish than in 1985, and there were fewer black rockfish than in 1986 (the high years for these two species). As in 1986, yellowtail rockfish recruited throughout much of the summer, with two major pulses. Thus, first-year yellowtail rockfish collected in late October represented two distinct size groups: one ranged from 40 to 50 mm SL, the other from 60 to 70

mm SL. As in previous years, there tended to be more first-year blue and black rockfish to the south, off of Sonoma County, and more first-year yellowtail rockfish to the north, off of Mendocino County (Table 2.)

Table 1. Mean number (standard error in parentheses) of first-year juveniles counted/min off the Mendocino coast during the same 4-week periods (early August to early September) from 1983 to 1987. N = number of 1-min observations.

Species	1983 N=36	1984 N=57	1985 N=50	1986 N=103	1987 N=112
S. flavidus	0.00	6.58	115.60	6.01	102.66
	(0.00)	(2.29)	(21.26)	(1.50)	(11.08)
S. mystinus	0.27	1.49	70.56	7.83	181.04
	(0.09)	(0.30)	(15.32)	(1.88)	(26.19)
S. melanops	0.41	0.31	4.34	9.52	7.58
	(0.14)	(0.08)	(1.54)	(2.08)	(1.24)
Total	0.68	8.38	190.50	23.35	291.67
	(0.19)	(2.33)	(29.82)	(3.91)	(33.99)

Table 2. Mean number (standard error in parentheses) of first-year juveniles counted/min during the same 4-week periods (early August to early September) over 4 years off the Sonoma and Mendocino County coasts.

	Mendocino				Sonoma			
Species	1984 N=57	1985 N=50	1986 N=103	1987 N=112	1984 N=37	1985 N=84	1986 N=60	1987 N=62
S. flavidus	6.58	115.60	6.01	102.66	4.39	135.17	6.73	89.39
	(2.29)	(21.26)	(1.50)	(11.08)	(1.48)	(26.00)	(2.29)	(18.42)
S. mystinus	1.49	70.56	7.82	181.04	4.89	117.63	15.27	328.05
	(0.30)	(15.32)	(1.88)	(26.19)	(1.29)	(19.50)	(3.81)	(52.15)
S. melanops	0.31	4.34	9.52	7.58	1.63	4.40	3.00	4.48
	(0.08)	(1.54)	(2.08)	(1.24)	(0.52)	(1.17)	(1.31)	(1.70)
Total	8.38	190.50	23.35	291.67	10.91	257.20	24.97	442.48
	(2.33)	(29.76)	(3.91)	(33.19)	(2.12)	(35.38)	(5.17)	(66.72)

The numbers of first-year juvenile rockfishes in the stomach contents of king salmon showed a similar trend (Table 3). A study by Biological Technician Wayne Samiere under the direction of Fishery Biologist Peter Adams determined that the shortbelly rockfish (*S. jordani*) was the major prey, as in previous years. But this year the chilipepper (*S. goodei*), a species previously unseen in salmon stomachs, supplanted the widow rockfish (*S. entomelas*) as the second-ranked prey.

Table 3. Mean number (standard error in parentheses) of first-year juveniles (all species) per stomach of king salmon from the Gulf of the Farallones, 1983-1987. N = number of stomachs examined.

1983 N=413	1984 N=503	1985 N=760	1986 N=243	1987 N=117[1]
<0.01 (-)[2]	1.61 (0.31)	4.71 (0.49)	0.97 (0.96)	8.38 (0.85)

[1]Analysis incomplete.
[2]Total of two juveniles found in samples.

Thus, the year-to-year variability identified in these studies occurs both within and between species. It has become increasingly clear that years of strong recruitment for some species may or may not be years of strong recruitment for others. (E. Hobson, FTS 556-0568)

GROUNDFISH ANALYSIS INVESTIGATION

Pelagic Juvenile Rockfishes Rare in Newly Upwelled Water

Fishery Biologists William Lenarz and Tina Wyllie Echeverria, and Biological Technicians Carol Reilly, David Woodbury, Don Pearson, Anne McBride, and Ralph Larson have begun a study of several aspects of the distribution and abundance of pelagic age-0 rockfishes between Monterey and Point Reyes, based on data gathered during cruises conducted each spring since 1983. Fish were sampled in midwater trawls conducted from the NOAA Ship *David Starr Jordan*, using a modified Stauffer trawl with a 12.5-m^2 opening deployed at depths ranging from 4 to 100 m (usually 30 m). In determining the relation between the distribution of pelagic juvenile rockfish and nearshore oceanographic features such as upwelling plumes, they gathered oceanographic data by conducting CTD surveys in the study area, recording continuous 2-m temperature and salinity readings using the CAMAC data bus, and obtaining AVHRR satellite images of sea surface temperature.

Preliminary analysis of data from the cruise of April 10-22, 1987, suggests that juvenile rockfish are rare in water that was upwelling shortly before the time of sampling. Temperature and salinity contours derived from CAMAC data (Figure 1) indicate two centers of upwelling during this cruise: a major center extending south from Point Reyes (at 38°N), and another small

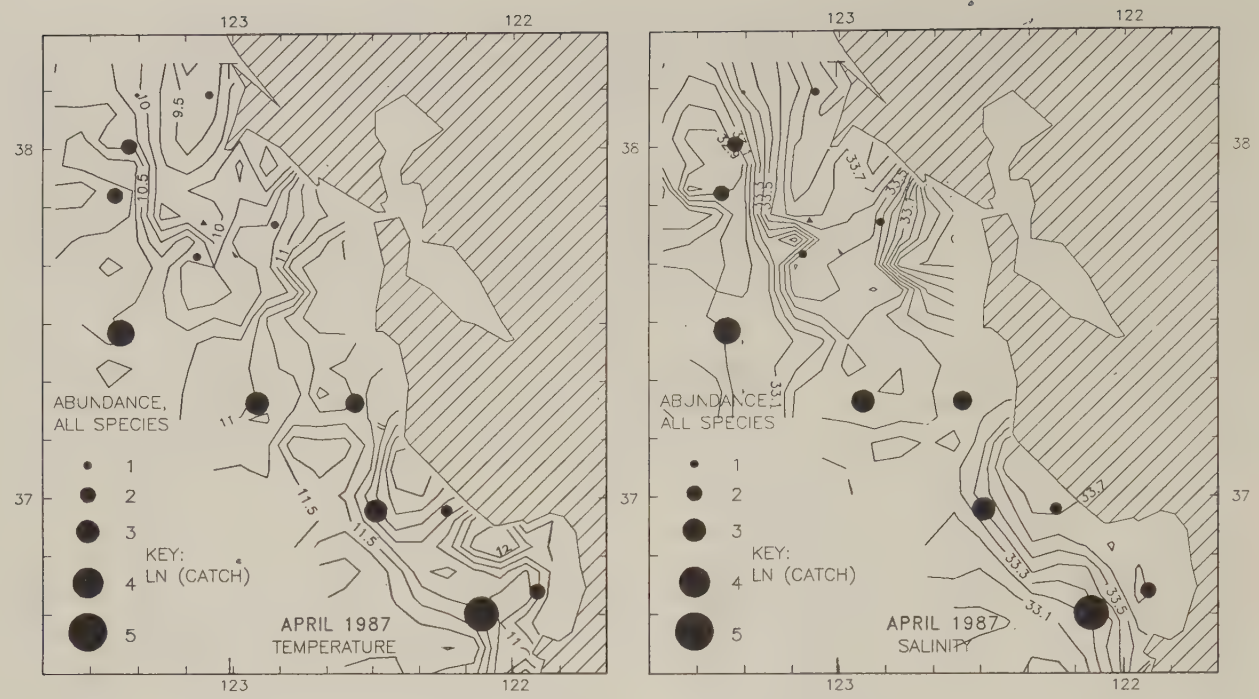


Figure 1. Distribution of pelagic age-0 rockfishes off central California during April 1987 in relation to 2-m temperature (left) and salinity (right). Sizes of solid circles are proportional to averages over two to six stations of the $\log_e$-catches of pelagic juveniles in a 12.5-m^2 opening midwater trawl deployed for 15 minutes at depth. Dotted ellipses indicate general locations of stations. Depth of headrope on most hauls was 30 m.

center north of Monterey Bay (at 38°10'N). The highly saline water within Monterey Bay (36°40' to 37°N) is likely to have been newly upwelled water and not to have mixed with offshore waters. The geometric mean catch of juvenile rockfish, over areas, was just below 10 per trawl, ranging from zero to several hundred. Fifteen species of rockfish were identified from the trawls, with chilipepper (*Sebastes goodei*) and shortbelly rockfish (*S. jordani*) dominating the catches. Rockfish were generally not abundant within the cool and/or saline water masses, but were much more abundant outside of these cool tongues. Lenarz et al. think that the source of upwelled water contains few pelagic juvenile rockfish, accounting for their dearth in upwelling plumes.

Lenarz and staff are interested in determining whether the April 1987 observation is generally true, and in inferring the movements of pelagic juveniles under different hydrographic conditions from temporally stratified observations of the study area carried out in May and June. Inferences about movements will also be aided by their ongoing analysis of the bathymetric distributions of pelagic juveniles. (R. Larson, FTS 556-0565)

INFORMATION TECHNOLOGY SERVICES

Performance of Continuous Data Acquisition System Aboard *Jordan* Assessed

Computer Systems Programmer Susan Jacobson of the Information Technology Services group is in the process of evaluating the performance of the hardware and software systems aboard the NOAA Ship *David Starr Jordan* during the recently concluded dolphin survey cruise in the eastern tropical Pacific. The shipboard computerized data collection system records oceanographic information--date, time, latitude, longitude, ship speed and heading, Loran readings, salinity, wind direction and speed, and water temperature. The information is automatically collected by sensors via a stand-alone CAMAC collector processed on the shipboard Molecular computer, according to the scientific requirements, and output to the hard disk and magnetic tape.

During the cruise which began July 30 and ended December 10, the continuous data acquisition system provided long stretches of 24-hour data collection. The system was shut down while in port and when the air conditioning equipment failed. In Jacobson's view the system performed well, with only two peripheral pieces of hardware totally non-functional upon return.

While the ship is in San Diego, Jacobson is examining and coordinating maintenance of equipment in preparation for the 1988 cruises. At this time the first two legs of data files have been verified and released. The final two are undergoing the verification process now and Information Technology Services plans to release them in early January. (S. Jacobson, FTS 893-7060)

STATUS OF PUBLICATIONS

Published

Ambrose, David A., Richard L. Charter, H. Geoffrey Moser, and Celeste R. Santos Methot. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1955. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-83, 185 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1955. It is the fifth report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1308 stations was occupied during 9 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table. Another key table lists, by station and month, standardized counts of each of the 124 larval fish categories identified from survey samples. This and previous and subsequent reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Ambrose, David A., Richard L. Charter, H. Geoffrey Moser, and Celeste R. Santos Methot. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1960. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-88, 253 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1960. It is the tenth report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1814 stations was occupied during 10 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table.

Another key table lists, by station and month, standardized counts of each of the 158 larval fish categories identified from survey samples. This and previous and subsequent reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Boehlert, G. W. and T. Sasaki. 1987. Spawning and dispersal of armorhead in the northeast Pacific and recruitment to isolated seamounts. [Abstract] EOS, Trans. Am. Geophys. Union 68:1751

Holt, R. S. 1987. Estimating density of dolphin schools in the eastern tropical Pacific Ocean by line transect methods. Fish. Bull., U.S. 85(3):419-434.

Data were collected from aerial and research ship surveys to estimate density of dolphin schools in the eastern tropical Pacific using line transect (LT) theory. The surveys were conducted from 1977 through 1983. Several assumptions of LT theory were investigated for both aerial and ship data. Factors were developed to alleviate effects of suspected violations of the assumptions. I estimated densities from data stratified into an inshore area surveyed by planes and an offshore area surveyed by ships. The density estimate for the inshore area was 4.18 schools/1,000 km^2 and 2.04 for the offshore area. For the entire area, the density estimate was 2.71 schools/1,000 km^2. Adjustments for possible biases owing to adverse sea state and sun glare conditions increased the inshore estimate by 8% and the total area estimate by 4%.

Holt, Rennie S. and John Cologne. 1987. Factors affecting line transect estimates of dolphin school density. J. Wildl. Manage. 51(4):836-843.

An experimental aerial survey of dolphins was conducted to investigate the effects of sea state, sun glare, cloud cover, and observer experience on line transect estimates of school density and detectability. Although estimates during rough seas were lower than estimates during calm seas, and estimates from inexperienced observer teams were lower than estimates from experienced teams, these differences were not significant. School density estimates during poor visibility conditions, due to sun glare or cloud cover, were 39% smaller than during good conditions. Therefore, aerial survey designs should position tracklines to minimize glare under and forward of the plane. If possible, sea-state conditions greater than Beaufort 3 should be avoided, and experienced observers should be utilized.

Holt, R. S., T. Gerrodette, and J. B. Cologne. 1987. Research vessel survey design for monitoring dolphin abundance in the eastern tropical Pacific. Fish. Bull., U.S. 85(3):435-446. During 1986 the National Marine Fisheries Service began

conducting long-term research ship surveys to determine status of spotted dolphin, *Stenella attenuata*, stocks in the eastern tropical Pacific. This is the main dolphin species taken incidentally by the yellowfin tuna, *Thunnus albacares*, purse seine fishery. We used research vessel survey data collected from 1977 to 1983 to investigate the annual changes in spotted dolphin population size that could be detected given various levels of research vessel survey effort during specified time periods for several levels of statistical error.

We find that two research vessels each operating for 120 days per year for 5 years (six surveys) could detect a 10% annual rate of decrease in dolphin abundance (a total 41% decrease over 5 years) with alpha and beta error levels of 10%. Adding a third vessel would provide better coverage of the dolphin's range, but would allow only a slightly lower rate of decrease to be detected (an 11% annual rate, for a total decrease of 44%). These numbers point out the difficulty of detecting even major changes in spotted dolphin population size with present survey methods. Alternatives are discussed, but all either cost more money, require a longer time to detect a decline, or accept higher levels of statistical error.

Kendall, A. W., Jr., M. E. Clarke, M. M. Yoklavich, and G. W. Boehlert. 1987. Distribution, feeding, growth of larval walleye pollock, *Theragra chalcogramma*, from Shelikof Strait, Gulf of Alaska. Fish. Bull., U.S. 85:499-521.

Walleye pollock in the Gulf of Alaska have recently been found to form an intense spawning aggregation in late winter in Shelikof Strait. This produces a dense patch of planktonic eggs in early April, and later in spring a patch of larvae that can be followed as it drifts to the southwest. The density of larvae observed in 1981 indicated that density-dependent effects on feeding may be important for larval survival. In May 1983 we conducted a field study to investigate spatial and vertical distribution, feeding, and growth of larvae from this spawning. During this study we found, in an area of maximum concentration (1 larva m^{-3}) located by an initial survey, larvae averaged 11.1 mm SL, and were similar in size to those found elsewhere. The larvae in 1983 were larger, and less abundant than at the same time in 1981. Larval growth was estimated from the number of otolith daily growth increments at size of larva and was similar in the area of maximum concentration and in other areas. Larvae were concentrated vertically between about 15 and 50 m and showed a crepuscular pattern of increased density at 14-28 m during twilight. Neither the vertical nor horizontal patterns of larval occurrences seemed closely associated with particular values of temperature or salinity. Most larvae were found in a temperature range of 7.0°-5.5°C and a salinity range of 31.5-32.2°/₀₀. Guts of larvae collected during darkness

contained less food than those from daytime. Copepod nauplii were largely replaced by *Pseudocalanus* spp. copepodids in the diet of larvae larger than 14 mm. At the densities of walleye pollock larvae observed in this study, it appears that zooplankton production in the area did not impact larval growth, even in the area of maximum density.

Moksness, Erlend, John Butler, and Richard L. Radtke. 1987. Estimation of age and growth rate in Norwegian spring spawning herring (*Clupea harengus* L.) larvae and juveniles. Sarsia 72:341-342. Bergen. ISSN 0036-4827.

Herring larvae and juveniles were aged by use of developmental stages and daily growth increments in the otoliths. The results indicate that developmental stages are useful in ageing larvae till the end of the yolk-sac stages, while daily growth increments in the otoliths are to be preferred in older larvae and juveniles.

Owen, R. W. and Carol A. Kimbrell. 1987. Micropatch sampler data. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-91, 54 p.

Sandknop, Elaine M., Richard L. Charter, H. Geoffrey Moser, and Celeste R. Santos Methot. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1952. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-80, 207 p

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1952. It is the second report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1491 stations was occupied during 11 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table. Another key table lists, by station and month, standardized counts of each of the 120 larval fish categories identified from survey samples. This and previous and subsequent reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Sandknop, Elaine M., Richard L. Charter, H. Geoffrey Moser, and Celeste R. Santos Methot. 1987. Ichthyoplankton and

station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1958. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-86, 248 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1958. It is the first report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1884 stations were occupied during 12 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table. Another key table lists, by station and month, standardized counts of each of the 151 larval fish taxa identified from survey samples. This and subsequent reports will make the CalCOFI ichthyoplankton and station data available to all investigators and will serve as guides to the newly developed computer data base.

Stevens, Elizabeth G., Richard L. Charter, H. Geoffrey Moser, and Morgan S. Busby. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1953. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-81, 186 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1953. It is the third report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1429 stations was occupied during 12 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table. Another key table lists, by station and month, standardized counts of each of the 108 larval fish categories identified from survey samples. This and previous and subsequent reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Stevens, Elizabeth G., Richard L. Charter, H. Geoffrey Moser, and Morgan S. Busby. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1956. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-84, 189 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1956. It is the sixth report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1407 stations was occupied during 12 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table. Another key table lists, by station and month, standardized counts of each of the 136 larval fish categories identified from survey samples. This and previous and subsequent reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Stevens, Elizabeth G., Richard L. Charter, H. Geoffrey Moser, and Morgan S. Busby. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1959. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-87, 273 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1959. It is the ninth report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 2182 stations was occupied during 12 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table. Another key table lists, by station and month, standardized counts of each of the 155 larval fish categories identified from survey samples. This and previous and subsequent

reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Sumida, Barbara Y., Richard L. Charter, H. Geoffrey Moser, and Deborah L. Snow. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1954. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-82. 207 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1954. It is the fourth report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1473 stations were occupied during 10 multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 5 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table. Another key table lists, by station and month, standardized counts of each of the 129 larval fish taxa identified from survey samples. This with previous and subsequent reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Sumida, Barbara Y., Richard L. Charter, H. Geoffrey Moser, and Deborah L. Snow. 1987. Ichthyoplankton and station data for California Cooperative Oceanic Fisheries Investigations survey cruises in 1957. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-85, 225 p.

This report provides ichthyoplankton and associated station and tow data from California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises conducted off California and Baja California in 1957. It is the seventh report in a series that presents these data for all biological-oceanographic CalCOFI surveys from 1951 to the present. A total of 1483 stations was occupied during 12 monthly multivessel cruises over the quarter-million square mile survey area which extends from the California-Oregon border to Cape San Lucas, Mexico and seaward to several hundred miles. The data are listed in a series of 6 tables; the background, methodology, and information necessary for interpretation and quantitative analysis of the data are presented in an accompanying text. All pertinent station and tow data, including volumes of water strained and standard haul factors are listed in the first table.

Another key table lists, by station and month, standardized counts of each of the 149 larval fish categories identified from survey samples. This and previous and subsequent reports make the CalCOFI ichthyoplankton and station data available to all investigators and serve as guides to the newly developed computer data base.

Approved by Center Director

Au, David W., Michael M. Scott, and Wayne L. Perryman. Leap-swim behavior of "porpoising" dolphins. For consideration for publication in Cetus.

Barlow, Jay. Harbor porpoise (*Phocoena phocoena*) abundance estimation based on ship surveys in California, Oregon and Washington. For consideration for publication in Fishery Bulletin, U.S.

Hobson, Edmund S. and James R. Chess. Trophic relationships of the blue rockfish, *Sebastes mystinus*, in a coastal upwelling system off northern California. For consideration for publication in Fishery Bulletin, U.S.

Humphreys, Robert L., Gary A. Winans, and Darryl T. Tagami. Synonymy and proposed life history of the North Pacific armorhead, *Pseudopentaceros wheeleri* Hardy. For consideration for publication in Copeia.

Lasker, Reuben. The determinants of recruitment. Chapter in a book.

Moffitt, Robert B., Frank A. Parrish, and Jeffrey J. Polovina. Community structure, biomass, and productivity of deepwater artificial reefs in Hawaii. For consideration for publication in the Bulletin of Marine Science.

Polovina, Jeffrey J., Alan R. Everson, and Thomas K. Kazama. Evaluation of circular and rectangular escape vents in a multispecies lobster fishery in Hawaii. For Proceedings of the Fortieth Annual Gulf and Caribbean Fisheries Institute.

Seckel, Gunter R. Indices for mid-latitude North Pacific winter wind systems: An exploratory investigation. For consideration for publication in Geojournal.

Squires, Dale and Samuel F. Herrick, Jr. Productivity measurement in common property resource industries: An application to the Pacific coast trawl fishery. For consideration for publication in the Canadian Journal of Economics.

Squires, Dale and James E. Kirkley. Product regulation in multiproduct industries: An application of the long-run

revenue function to Pacific marine fisheries. For consideration for publication in the Journal of Political Economy.

Ueber, Edward. A description of the traditional central California setnet fishery. For consideration for publication in the Journal of Marine Resource Economics.

Administrative Reports

Gerrodette, T., B. K. Choy, and L. M. Hiruki. 1987. An experimental study of derelict gill nets in the central Pacific Ocean. Southwest Fish. Cent. Honolulu Lab., Natl.

Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-87-18, 12 p.

Gilmartin, W. G. 1987. Hawaiian monk seal die-off response plan, a workshop report, 2 April 1980, San Diego, California. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-87-19, 7 p. plus Appendixes.

Fuqua, J. L. 1987. Hawaiian Island mapping program. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-87-20, 138 p.

Shomura, R. S. 1987. Hawaii's marine fishery resources: Yesterday (1900) and today (1986). Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-87-21, 14 p.

Translations

Darnitsky, V. B. 1980. On the synoptic variability of the geostrophic circulation in areas of underwater elevations in the North Pacific Ocean. Works of the Far Eastern Regional Scientific Research Institute of the Order of the Red Banner of Labor. Problems of Oceanography. Gidrometeoizdat, Leningrad, No. 86, p. 63-70. (Engl. transl. by W. G. Van Campen, 1987, 9 p., Transl. No. 120; available Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.)

Darnitsky, V. B. 1985. Some causes of variability in the bio- and fish-productivity of the mesopelagial (near seamounts). Ministry of Fisheries of the U.S.S.R. All-Union Scientific Research Institute for Fisheries and Oceanography (VNIRO). Investigation and Rational Utilization of the Bioresources of the Open Ocean (Fishes of the Mesopelagial). Papers of the All-Union Conference, Moscow, p. 102-123. (Engl.

transl. by W. G. Van Campen, 1987, 18 p., Transl. No. 121; available Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.)

Darnitsky, V. B., N. I. Zigel'man, and S. A. Shakhunova. 1984. Variability of the levels of nutrient content in the boundary layer of the Wanganella Bank. State Committee of the U.S.S.R. on Hydrometeorology and Monitoring the Natural Environment. Works of the Far Eastern Regional Scientific Research Institute of the Order of the Red Banner of Labor. Problems of the Oceanography of the Pacific Ocean and Far Eastern Seas. Gidrometeoizdat, Leningrad, No. 111, p. 107-116. (Engl. transl. by W. G. Van Campen, 1987, 9 p., Transl. No. 123; available Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.)

Kozlov, V. F., V. B. Darnitsky, and M. I. Ermakov. 1982. An experiment in mathematical modeling of topographic vortices over seamounts. Works of the Far Eastern Regional Scientific-Research Institute of the Order of the Red Banner of Labor. Problems of Oceanography of the Pacific Ocean and Far Eastern Seas. Leningrad 96:3-25. (Engl. transl. by W. G. Van Campen, 1987, 25 p., Transl. No. 119; available Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.)

Yoshimura Industry Co., Ltd. [No date.] How to preserve freshness in tunas, Part II [Shime shime maguro (sashimi-yō) no tsukurikata]. Yoshimura Industry Co., Ltd., [Osaka, Japan], 34 p. (Engl. transl. by Tamio Otsu, 1987, 53 p., Transl. No. 122; available Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.)

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